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SKYHAWK AIRCRAFT

A/TA-4K

FLIGHT MANUAL

A handwritten signature in black ink, appearing to read 'Daniel Fortner', is written over the printed name.

**AIR COMMODORE
AIR OFFICER COMMANDING
RNZAF OPERATIONS GROUP**

APPROVING OFFICER : SASO OPHQ

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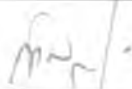
Total number of pages in this publication is 535 consisting of the following:

Page No	AL No	Page No	AL No	Page No	AL No	Page No	AL No
Auth	N/A	1-20	6	1-57	0	2-23	8
0-1	13*	1-21	11	1-58	0	2-24	8
0-2	13*	1-22	12	1-59	0	2-25	8
0-3	13*	1-23	8	1-60	0	2-26	7
0-4	12	1-24	0	1-61	6	2-27	10
0-5	8	1-25	0	1-62	0	2-28	8
0-6	8	1-26	0	1-63	0	2-29	8
0-7	0	1-27	0	1-64	0	2-30	8
0-8	0	1-28	0	1-65	0	2-31	7
0-9	0	1-29	0	1-66	0	2-32	7
0-10	8	1-30	0			2-33	8
0-11	8	1-31	0			2-34	8
		1-32	0	Chapter 2		2-35	8
Chapter 1		1-33	0	2-I	10	2-36	8
1-I	8	1-34	0	2-II	7		
1-II	5	1-35	8	2-1	8	Chapter 3	
1-III	8	1-36	0	2-2	8	3-I	0
1-IV	8	1-37	0	2-3	8	3-II	0
1-1	7	1-38	8	2-3a	8	3-1	0
1-2	0	1-39	8	2-3b	8	3-2	7
1-3	0	1-39a	8	2-4	8	3-3	7
1-4	0	1-39b	8	2-5	6	3-4	0
1-5	7	1-40	8	2-6	6	3-5	0
1-6	5	1-41	8	2-7	7	3-6	0
1-7	8	1-42	8	2-8	8	3-7	0
1-8	8	1-43	8	2-9	8	3-8	0
1-8a	8	1-44	0	2-10	8	3-9	0
1-8b	8	1-45	0	2-11	8	3-10	0
1-9	0	1-46	0	2-12	9	3-11	0
1-10	5	1-47	0	2-13	8	3-12	7
1-11	7	1-48	5	2-14	8	3-13	7
1-12	5	1-49	0	2-15	7	3-14	0
1-13	8	1-50	5	2-16	8	3-15	0
1-14	11	1-51	5	2-17	7	3-16	7
1-15	8	1-52	5	2-18	8	3-17	0
1-16	8	1-53	0	2-19	8	3-18	0
1-17	8	1-54	0	2-20	7	3-19	0
1-18	8	1-55	0	2-21	8	3-20	0
1-19	8	1-56	0	2-22	8		

Page No	AL No	Page No	AL No	Page No	AL No	Page No	AL No
<u>Chapter 4</u>		5-33	8	5-85	11	7-16	0
4-I	8	5-34	8	5-86	11	7-17	0
4-II	7	5-35	8	5-87	11	7-18	9
4-1	5	5-36	8	5-88	8	7-19	5
4-2	12	5-37	8			7-20	5
4-3	9	5-38	8	<u>Chapter 6</u>		7-21	5
4-4	0	5-39	8	6-I	8	7-22	0
4-5	8	5-40	8	6-II	0	7-23	0
4-6	0	5-41	8	6-1	3	7-24	0
4-7	7	5-42	8	6-2	0	7-25	8
4-8	7	5-43	8	6-3	0	7-26	5
4-9	0	5-44	8	6-4	4	7-27	5
4-10	0	5-45	8	6-5	0	7-28	5
		5-46	8	6-6	0	7-29	5
		5-47	8	6-7	0	7-30	0
<u>Chapter 5</u>		5-48	8	6-8	4	7-31	5
5-I	8	5-49	8	6-9	0	7-32	0
5-II	8	5-50	8	6-10	0	7-33	0
5-III	11	5-51	8	6-11	0	7-34	8
5-IV	11	5-52	8	6-12	0	7-34a	8
5-1	8	5-52a	8	6-13	4	7-34b	8
5-2	8	5-52b	8	6-14	0	7-35	8
5-3	8	5-53	7	6-15	0	7-36	0
5-4	8	5-54	7	6-16	0	7-37	0
5-5	8	5-55	7	6-17	4	7-38	0
5-6	8	5-56	7	6-18	8	7-39	0
5-7	8	5-57	7	6-19	8	7-40	0
5-7a	8	5-58	7	6-20	8	7-41	0
5-7b	8	5-59	7	6-21	8	7-42	0
5-8	8	5-60	7	6-22	8	7-43	0
5-9	8	5-61	7	6-23	8	7-44	0
5-10	8	5-62	7	6-24	8	7-45	0
5-11	8	5-63	7			7-46	0
5-12	8	5-64	7	<u>Chapter 7</u>		7-47	0
5-13	0	5-65	7	7-I	5	7-48	0
5-14	8	5-66	7	7-II	8	7-49	0
5-15	7	5-67	7	7-III	8	7-50	0
5-16	8	5-68	7	7-IV	8	7-51	0
5-17	7	5-69	7	7-1	0	7-52	0
5-18	7	5-70	7	7-2	0	7-53	0
5-19	8	5-71	7	7-3	0	7-54	0
5-20	8	5-72	7	7-4	0	7-55	0
5-21	7	5-73	7	7-5	0	7-56	0
5-22	8	5-74	13*	7-6	0	7-57	0
5-23	8	5-75	13*	7-7	9	7-58	0
5-24	8	5-76	13*	7-8	9	7-59	0
5-25	8	5-77	7	7-9	9	7-60	0
5-26	8	5-78	7	7-10	0	7-61	0
5-27	8	5-79	13*	7-11	0	7-62	0
5-28	8	5-80	8	7-12	0	7-63	0
5-29	8	5-81	11	7-13	0	7-64	0
5-30	8	5-82	11	7-14	0	7-65	0
5-31	8	5-83	11	7-15	0	7-66	0
5-32	8	5-84	11			7-67	0

Page No	AL No	Page No	AL No	Page No	AL No	Page No	AL No
7-68	0	9-III	0	9-46	7	9-93	7
		9-IV (Blank)	0	9-47	7	9-94	7
<u>Chapter 8</u>		9-1	0	9-48	7	9-95	7
8-I	0	9-2	0	9-49	7	9-96	7
8-II	0	9-3	0	9-50	7	9-97	7
8-III	0	9-4	0	9-51	7	9-98	0
8-IV	0	9-5	0	9-52	7	9-99	0
8-1	0	9-6	0	9-53	7	9-100	7
8-2	6	9-7	0	9-54	7	9-101	7
8-3	0	9-8	7	9-55	7	9-102	7
8-4	0	9-9	0	9-56	7	9-103	7
8-5	0	9-10	0	9-57	7	9-104	7
8-6	0	9-11	0	9-58	7	9-105	7
8-7	0	9-12	0	9-59	7	9-106	7
8-8	0	9-13	0	9-60	7	9-107	7
8-9	0	9-14	0	9-61	7	9-108	7
8-10	0	9-15	0	9-62	7	9-109	7
8-11	0	9-16	0	9-63	7	9-110	7
8-12	0	9-17	0	9-64	7	9-111	7
8-13	5	9-18	7	9-65	7	9-112	7
8-14	5	9-19	7	9-66	7	9-113	0
8-15	0	9-20	7	9-67	7	9-114	0
8-16	0	9-21	7	9-68	7	9-115	0
8-17	0	9-22	7	9-69	7	9-116	0
8-18	0	9-23	7	9-70	7	9-117	7
8-19	0	9-24	7	9-71	7	9-118	7
8-20	0	9-25	7	9-72	7	9-119	7
8-21	6	9-26	0	9-73	7	9-120	7
8-22	0	9-27	0	9-74	0	9-121	7
8-23	0	9-28	7	9-75	0	9-122	7
8-24	0	9-29	7	9-76	0	9-123	7
8-25	0	9-30	7	9-77	7	9-124	7
8-26	0	9-31	7	9-78	7	9-125	7
8-27	0	9-32	7	9-79	7	9-126	7
8-28	0	9-33	7	9-80	7		
8-29	0	9-34	7	9-81	0	<u>Foldouts</u>	
8-30	0	9-35	7	9-82	0	FO-1	0
8-31	0	9-36	7	9-83	0	FO-2	0
8-32	0	9-37	7	9-84	7	FO-3	0
8-33	0	9-38	0	9-85	7	FO-4	0
8-34	6	9-39	0	9-86	7	FO-5	0
8-35	0	9-40	0	9-87	7	FO-6	0
8-36	0	9-41	0	9-88	7	FO-7	0
		9-42	0	9-89	7	FO-8	0
<u>Chapter 9</u>		9-43	0	9-90	7	FO-9	0
9-I	0	9-44	0	9-91	0	FO-10	0
9-II	0	9-45	0	9-92	7	END	

INCORPORATED: Signature:



Date: 5/12/00

AL 12(11)

Foreword

1. This Manual contains information on all Skyhawk aircraft systems; either new, or modified as part of Project Kahu. It contains performance data and operating procedures required for safe and effective operations. However, it is not a substitute for sound judgement. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein.
2. This manual is authorised as a mandatory publication for RNZAF use. Where information in this publication conflicts with other NZAPs the order of precedence laid down in NZAP 6000.001-1 is to apply.
3. The foreign source manuals included as references in this publication are listed on PICS, either under their foreign source number, or under an assigned NZAP number. In situations where any reference publications have not been converted to NZAPs, the Approving Authority for the publication containing the reference(s) is to be advised without delay.
4. This publication is sponsored by OCOW, RNZAF Base Ohakea, and amendment proposals are to be submitted through normal channels (on an ALIS Work Order Pre Plan File 50330 000-60, where available) in accordance with NZAP 6000.001-1.

Warnings, Cautions And Notes

5. The following definitions apply to Warnings, Cautions and Notes found throughout this manual:

WARNING

- An operating procedure, practice, or condition, etc., which may result in injury or death, if not carefully observed or followed.

CAUTION

- An operating procedure, practice, or condition etc., which may result in damage to equipment if not carefully observed or followed.

NOTE

- An operating procedure, practice, or condition, etc., which is essential to emphasize.

Lasaposs And Lasaprac

6. The following definitions apply to LASAPOSS and LASAPRAC:

LASAPOSS - Land at the nearest airfield with a runway greater than 4,000 feet at which a safe landing can be made.

LASAPRAC - Extended flight is not recommended. The landing site and duration of flight is at the discretion of the pilot in command.

Wording

7. The concept or word usage and intended meaning which has been adhered to in preparing this Manual is as follows:

“Shall” has been used only when application of a procedure is mandatory.

“Should” has been used only when application of a procedure is recommended.

“May” and “need not” have been used only when application of a procedure is optional.

“Will” has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.

AL 8(7)

CONTENTS

CHAPTER 1 THE AIRCRAFT

	PAGE		PAGE
GENERAL DESCRIPTION	1-1	LANDING AND ARRESTING SYSTEMS	1-28
PROPULSION SYSTEM	1-5	FLIGHT INSTRUMENTS	1-33
FUEL SYSTEM	1-9	AUTOMATIC FLIGHT CONTROL SYSTEM ..	1-40
ELECTRICAL SYSTEM	1-17	COCKPIT ENCLOSURE	1-46
LIGHTING	1-20	EJECTION SEAT	1-51
HYDRAULIC SYSTEM	1-23	OXYGEN SYSTEM	1-57
FLIGHT CONTROLS AND SURFACES	1-24	ENVIRONMENTAL SYSTEMS	1-59

CHAPTER 2 NORMAL PROCEDURES

	PAGE		PAGE
INTRODUCTION	2-1	POST FLIGHT	2-25
PRE FLIGHT	2-1	SHUTDOWN	2-26
TAKEOFF	2-18	SPECIAL GROUND PROCEDURES	2-27
IN-FLIGHT	2-21	HOT REFUELLING PROCEDURES	2-27
LANDING	2-22	AIR TO AIR REFUELLING PROCEDURES ...	2-28

CHAPTER 3 FLIGHT CHARACTERISTICS

	PAGE		PAGE
INTRODUCTION	3-1	FLIGHT WITH EXTERNAL STORES	3-9
FLIGHT CONTROLS	3-1	MANOEUVRING FLIGHT	3-10
TAKEOFF AND LANDING CHARACTERISTICS	3-4	OUT OF CONTROL FLIGHT	3-15
LEVEL FLIGHT CHARACTERISTICS	3-5	SLAT OPERATING CHARACTERISTICS	3-18
TRANSONIC MACH CHARACTERISTICS	3-5	FLIGHT CHARACTERISTICS ON AFCS	3-19

AL 8(7)

CHAPTER 4 OPERATING LIMITATIONS

	PAGE		PAGE
ENGINE LIMITATIONS	4-1	AIR REFUELLING STORE	4-9
AIRFRAME LIMITATIONS	4-2		

CHAPTER 5 EMERGENCY PROCEDURES

	PAGE		PAGE
GENERAL	5-1	PRECAUTIONARY APPROACHES	5-16
GROUND EMERGENCIES	5-1	FIRE	5-22
TAKEOFF EMERGENCIES	5-3	SYSTEMS FAILURES	5-25
HANDLING EMERGENCIES	5-6	AIR REFUELLING STORE FAILURE	5-42
MIDAIR/BIRDSTRIKE/COMBAT		LANDING EMERGENCIES	5-44
STRUCTURAL FAILURE OR DAMAGE	5-8	EMERGENCY EXIT	5-52b
ENGINE MALFUNCTIONS	5-9	DITCHING	5-53
OIL SYSTEM MALFUNCTIONS	5-11	EJECTION	5-54
ENGINE FAILURE	5-11		

CHAPTER 6 TESTFLIGHT PROCEDURES

	PAGE
FUNCTIONAL TESTFLIGHT PROCEDURES ..	6-1

CHAPTER 7 NAVIGATION/ATTACK SYSTEM

	PAGE		PAGE
SYSTEM CONTROLS AND DISPLAYS	7-1	COMMUNICATIONS	7-30
DATA TRANSFER SYSTEM	7-19	NAVAIDS	7-35
AIRBORNE VIDEO TAPE RECORDER	7-20	APG-66 (NZ) RADAR	7-39
BUILT IN TEST	7-22	NAVIGATION	7-59
INERTIAL NAVIGATION UNIT	7-25		

CHAPTER 8 WEAPONS SYSTEMS

	PAGE		PAGE
ARMAMENT EQUIPMENT	8-1	COUNTER MEASURE DISPENSING SYSTEM ..	8-31
RADAR WARNING SYSTEM (RWS)	8-25		

CHAPTER 9 PERFORMANCE DATA

INTRODUCTION	9-1	RANGE	9-38
GENERAL PERFORMANCE DATA BASIS	9-1	ENDURANCE	9-74
DRAG INDEX SYSTEM	9-3	AIR REFUELLING	9-81
AIRSPED CORRECTIONS	9-6	DESCENT	9-91
ALTIMETER CORRECTIONS	9-7	LANDING	9-98
TAKEOFF	9-14	COMBAT PERFORMANCE	9-113
CLIMB	9-26		

FOLDOUTS

FOLDOUT	PAGE	FOLDOUT	PAGE
1 Aircraft Schematic	FO-1	6 Emergency Generator Deployed	FO-6
2 Equipment Locations	FO-2	7 BIT History Page Bit Assignments	FO-7
3 Cockpit Layouts	FO-3	8 Multiple Effect Failure Matrix	FO-8
4 NAS Major Components	FO-4	9 Fuel System	FO-9
5 Electrical Distribution (Main Generator On Line)	FO-5	10 Hydraulic System	FO-10

LIST OF ABBREVIATIONS, ACRONYMS AND DESIGNATIONS

A/A	Air to Air	ASL	Above Sea Level
AAM	Air to Air Missile	ATD	Along Track Distance
ACP	Armament Control Panel	ATE	Automatic Test Equipment
ACQ	Acquisition	ATT	Attitude
ACM	Air Combat Mode	AVTR	Airborne Video Tape Recorder
A/D	Analogue to Digital	AWW	Airborne/Armament/Control
ADF	Automatic Direction Finder	AZ	Azimuth
ADI	Attitude Director Indicator	BARO	Barometric Pressure
ADIO	Analog Discrete Inputs and Outputs	BAROSET	Barometric Pressure Setting
ADL	Armament Datum Line	BCN	Beacon
AFCs	Automatic Flight Control System	BDHI	Bearing/Distance/Heading/Indicator
A/G	Air to Ground	BDU	Bomb Dummy Unit
AGL	Above Ground Level	BFL	Bomb Fall Line
AGM	Air to Ground Missile	BIT	Built In Test
AGR	Air to Ground Ranging	BITE	Built-In-Test Equipment
AIB	Analogue Input Buffers	BRG	Bearing
AIU	AMUX Interface Unit	BRIL	Brilliance
AIM	Air Intercept Missile	BTFL	Bullet Trajectory Flight Line
AJB	Audio Junction Box	CAS	Calibrated Air Speed
ALE	Air/Countermeasures/Ejection Release	C-BIT	Continuous Built In Test
ALPH	Alphanumeric	CCIL	Continuously Computed Impact Line
ALR	Air/Countermeasures/Receiving, Passive Detecting	CCIP	Continuously Computed Impact Point
ALT	Altitude or Altimeter	CCRP	Continuously Computed Release Point
AM	Amplitude Modulation	ccw	Counter-clockwise
AMUX	Aircraft Multiplex (data bus)	CDC	Countermeasures Dispenser Control
ANT	Antenna	CDI	Course Deviation Indicator
AOA	Angle of Attack	CDS	Countermeasures Dispenser System
AP or A/P	Auto-Pilot	CEP	Circular Error Probability
APG	Air/Radar/Fire Control and Searchlight Detecting	CFG	Constant Frequency Generator
APN	Air/Radar/Navigation	CHF	Chaff
APP	Approach	CHG	Change
APX	Air/Radar/Identification and Recognition	CIU	Computer Interface Unit
ARB	Armament Relay Box	CLR	Clear
ARC	Air/Radio/Communications	COM/COMM	Communication
ARINC	Aeronautical Radio Incorporated	CRT	Cathode Ray Tube
ARN	Air/Radio/Navigational Aids	CPS	Compass
ARS	Air Refuelling System	CPU	Central Processing Unit
A/S	Air to Surface	CSE	Course
		CSS	Control Stick Steering
		CTD	Cross Track Distance

LIST OF ABBREVIATIONS, ACRONYMS AND DESIGNATIONS (continued)

CTRB	Control Transfer Relay Box	FCU	Fuel Control Unit
CTVS	Cockpit Television Sensor	FLIR	Forward Looking Infrared
cw	Clockwise	FLR	Flare
DADC	Digital Air Data Computer	FLT	Flight
DBS	Doppler Beam Sharpening	FM	Frequency Modulation
DCL	Declutter	FOV	Field Of View
DEB	Data Entry Box	FPM	Flight Path Marker
deg	Degree	FRAG	Fragment
DESIG	Designate	FRL	Fuselage Reference Line
DEST	Destination	FRZ	Freeze
DF	Direction Finder	FT	Feet
DFCC	Digital Flight Control Computer	FWD	Forward
DGRD	Degraded	GBU	Guided Bomb Unit
DISPL	Display	GCIB	Ground Crew Intercommunication Box
DMA	Direct Memory Access	GEN	Generator
DME	Distance Measuring Equipment	GM	Ground Map
DP	Display Processor	GND/GRD	Ground
DSP	Digital Signal Processor	GS	Glide Slope
DT	Designated Target	GSE	Ground Support Equipment
DTA	Data	HD	High Drag
DTL	Diode Transistor Logic	HDD	Head Down Display
DTM	Data Transfer Module	HDG	Heading
DTMR	Data Transfer Module Receptacle	HI	High
DTOA	Desired Time Of Arrival	HOTAS	Hands On Throttle And Stick
DTS	Data Transfer System	Hr	Hour
DU	Display Unit	HSI	Horizontal Situation Indicator
DVTS	Dive Toss	HST	History
EEPROM	Electrically Erasable Programmable Read Only Memory	HUD	Head Up Display
EGT	Exhaust Gas Temperature	HYD	Hydraulics
EILM	Extended Intermediate Level Maintenance	Hz	Hertz
EILTS	Expanded ILTS	I-BIT	Initiated Built-In-Test
EL/ELEV	Elevation	IAS	Indicated Air Speed
EM	Electro Magnetic	iaw	In Accordance With
EMERG	Emergency	ICS	Intercommunication System
ENT	Enter	IDENT	Identification
EPR	Engine Pressure Ratio	IDX	Index
ETA	Estimated Time Of Arrival	IF	Intermediate Frequency
ETI	Elapsed Time Indicator	IFF	Identification Friend or Foe
FCR	Fire Control Radar	IGN	Ignition
		IIR	Imaging Infrared
		ILM	Intermediate Level Maintenance
		ILS	Instrument Landing System
		ILTS	Intermediate Level Test Station

AL 8(0)

LIST OF ABBREVIATIONS, ACRONYMS AND DESIGNATIONS (continued)

IMN	Indicated Mach Number	MIC	Microphone
INS	Inertial Navigation System	min	Minute or Minimum
INT	Intensity	MK	Mark
INU	Inertial Navigation Unit	MPPU	Multipurpose Processing Unit
I/O	Input/Output	MR/MRAD	Milliradian
IP	Initial Point	MRK	Mark
IR	Infrared	MRTS	Maritime Toss
JMR	Jammer	ms	Millisecond
kHz	Kilo Hertz	MSL	Mean Sea Level
KIAS	Knots Indicated Airspeed	MTI	Moving Target Indicator
Kt	Knot	MTT	Maritime Target Track
Kts	Knots	MUX	Multiplex
LABS	Low Altitude Bombing System	NAS	Navigation Attack System
LAWS	Low Altitude Warning System	NAV	Navigation
LCOS	Lead Computing Optical Sight	NAVAIDS	Navigation Aids
LD	Low Drag	NLG	Nose Landing Gear
LED	Light Emitting Diode	nm	Nautical Mile
LGB	Laser Guided Bomb	NORM	Normal
LHS	Left Hand Side	NWS	Nose Wheel Steering
LL	Low Level	OFLY	Overfly
LOC	Localiser	OFPP	Operational Flight Program
LOS	Line Of Sight	OFST	Offset
LPA	Low Precautionary Approach	P-BIT	Power On Bit
LPRFU	Low Power Radio Frequency Unit	PLTS	Planned Toss
LRU	Line Replaceable Unit	PMBR	Practice Multiple Bomb Rack
LVPS	Low Voltage Power Supply	PPI	Plan Position Indicator
LWD	Left Wing Down	PRB	Power Relay Box
MAINT	Maintenance	PRF	Pulse Repetition Frequency
MAX	Maximum	PRG	Program
MBS	Millibars	PRI	Pulse Repetition Interval
MCCU	Master Caution Control Unit	PSP	Personal Service Panel
MDGT	Mission Data Ground Terminal	PUAC	Pull Up Anticipation Cue
MDT	Mission Data Terminal	QTY	Quantity
MDTP	Mission Data Transfer Programme	QVV	Quickened Velocity Vector
MDTS	Mission Data Transfer System	R/T	Receiver/Transmitter
MED	Medium	RADAR	Radio Detection And Ranging
MER	Multiple Ejector Rack	RAD ALT	Radar or Radio Altimeter
MFD	Multiple-Function Display	RAM	Random Access Memory
MHz	Megahertz	RAT	Ram Air Turbine
MI	Miles		

AL 8(0)

LIST OF ABBREVIATIONS, ACRONYMS AND DESIGNATIONS (continued)

RCP	Radar Control Panel	SRB	System Relay Box
RCU	Remote Control Unit	SRCH	Search
RCVR	Receiver	SSU	Sidewinder Simulator Unit
RDY	Ready	STA	Stuck Throttle Approach
REC	Receive	STAB AUG	Stability Augmentation
REL	Relative	STALO	Stable Local Oscillator
RER	Radial Error Rate	STBY	Standby
RET	Return	STD	Standard
RET SRH	Return to Search	STP	Step
RF	Radio Frequency	STRD	Stored
RKTS	Rockets	STT	Single Target Track
RLG	Ring Laser Gyro	SUU	Suspended Underwing Unit
RMAX	Maximum Range	SVM	Sealed Video Module
RMEV	Best Manoeuvre Range	TACAN	Tactical Air Navigation
RMIN	Minimum Range	TAE	Track Angle Error
RNG	Range	TAS	True Air Speed
ROM	Read Only Memory	TER	Triple Ejector Rack
RRS	Rain Removal System	TGT	Target
RT	Radio Telephony	TR or T/R	Transmit and Receive
RTC	Real Time Clock	TX	Transmit
RTFL	Rocket Trajectory Flight Line	UDT	Update
RWD	Right Wing Down	UFC	Up Front Controller
RWR	Radar Warning Receiver	UHF	Ultra High Frequency
RWS	Radar Warning System	UTIL	Utility
RX	Receive	UUT	Unit Under Test
SAM	Situation Awareness Mode	VHF	Very High Frequency
SCS	Sidewinder Control System	VIM	Video Interface Module
SEAM	Sidewinder Expanded Acquisition Mode	VOR	VHF Omni Range
SECS	Seconds	VORTAC	VHF Omni Range/Tacan
SEL	Select	VSI	Vertical Speed Indicator
SI-BIT	Specifically Initiated BIT	VV	Vertical Velocity or Velocity Vector
SIU	Sidewinder Interface Unit	WPN	Weapon
SMS	Stores Management System	WPNS	Weapons
SPD	Speed	WPT	Waypoint
		μS	Micro Second

AL 8(5)

CHAPTER 1

THE AIRCRAFT

PAGE	PAGE
GENERAL DESCRIPTION	1-1
INTRODUCTION	1-1
DIMENSIONS	1-1
PROPULSION SYSTEM	1-5
ENGINE	1-5
Compressor Airbleed System	1-5
Ignition	1-5
Starter	1-5
ENGINE FUEL SYSTEM	1-5
Fuel Pump	1-5
Fuel Control Unit	1-5
Manual Fuel Shutoff Control	1-5
ENGINE CONTROLS	1-6
Engine Control Panel	1-6
Fuel Control Switch	1-6
Manual Fuel Control Warning Light	1-7
Engine Starter Switch	1-7
Throttle	1-7
ENGINE INSTRUMENTS	1-8
Exhaust Gas Temperature Indicator	1-8
Tachometer	1-8
Engine Pressure Ratio Indicator	1-8
Fuel Flowmeter	1-8
OIL SYSTEM	1-8
Introduction	1-8
Oil Pressure Indicator	1-8
Low Oil Pressure Light	1-8a
Oil Quantity Indicator / Switch	1-8a
FUEL SYSTEM	1-9
INTRODUCTION	1-9
FUEL TANKS	1-9
Internal Tanks	1-9
External Tanks	1-9
FUEL TRANSFER	1-9
Wing Tank Transfer	1-9
Drop Tank Transfer	1-9
Emergency Transfer	1-10
Fuel Transfer Rates	1-10
Fuel Consumption Effects	
On Aircraft Centre Of Gravity	1-11
Wing Tank Fuel Dump And	
Pressure Relief Valve	1-12
Scupper Drain (Gang Drain)	1-12
Air Refuel Norm / Fus Only Switch	1-12
Fuel Transfer Normal/Bypass Switch	1-12
Fuel Boost Pump	1-13
Fuel Boost Pressure Indicator	1-13
FUEL QUANTITY INDICATING SYSTEM ..	1-13
Fuel Int-Ext Switch	1-13
Fuel Quantity Indicator	1-13
Low Fuel State Warning Indicator	1-14
SINGLE POINT FUELLING AND	
DEFUELLING SYSTEM	1-14
Pressure Fuelling Switch Panel	1-14
Pressure Fuelling	1-14
Pressure Defuelling	1-15
AIR REFUELLING (TANKER) SYSTEM	1-15
Air Refuelling Store	1-15
Air Refuelling Control Panel	1-15
<i>DROGUE POSITION</i> Indicator	1-15
<i>Gallons Delivered Counter</i>	1-16
<i>REFUEL</i> Master Switch	1-16
Store <i>DUMP</i> Light	1-16
Drogue Position Switch	1-16
Fuel Transfer Switch	1-16
Store <i>LIGHT</i> Switch	1-16
<i>SHIP TANK</i> Switch	1-16
Hose Jettison Switch	1-16
ELECTRICAL SYSTEM	1-17
POWER SUPPLY	1-17
Introduction	1-17
Variable Speed Constant Frequency System ..	1-17
Emergency Generator	1-17
Emergency Generator Release T-Handle ...	1-17
Emergency Generator Bypass Switch	1-18
50 Amp DC Converter	1-18
100 Amp DC Converter	1-18
CONTROL AND DISTRIBUTION	1-19
AC Power Control Switch	1-19
Retraction Release Switch System	1-19
Primary Bus	1-19
Monitored Bus	1-19
Primary-Monitored Bus	1-19
Armament Bus	1-19
Armament Safety Disable Switch	1-19
Fuse Panels	1-19
LIGHTING	1-20
EXTERIOR LIGHTS	1-20
Position Lights	1-20
Fuselage Lights	1-20
Anti Collision Lights	1-20
Taxi Light	1-20
Air Refuelling Probe Light	1-20
Master External Light Switch	1-20

CHAPTER 1 Cont.

THE AIRCRAFT

	PAGE		PAGE
INTERIOR LIGHTS	1-21	ARRESTOR HOOK	1-31
Primary Lighting	1-21	Operation	1-31
Console Lighting	1-21	Arrestor Hook Control	1-31
Red Floodlighting	1-21	DRAG CHUTE	1-32
White Floodlighting	1-21	BARRICADE ENGAGEMENT DETENTS	1-32
Warning And Caution Lights	1-21	FLIGHT INSTRUMENTS	1-33
Glareshield Warning Lights	1-21	HEAD UP DISPLAY	1-33
Fire Detection System	1-22	DISPLAY UNITS	1-33
Master Test Switch	1-22	HEADS DOWN FLIGHT INSTRUMENTS	1-33
HYDRAULIC SYSTEM	1-23	Combined Speed Indicator	1-33
INTRODUCTION	1-23	Vertical Velocity Indicator	1-33
SYSTEM DESCRIPTION	1-23	Altimeter	1-33
Capacity	1-23	Attitude Director Indicator	1-34
Operation	1-23	<i>Bank Angle Index</i>	1-34
FLIGHT CONTROLS AND SURFACES	1-24	<i>Bank Angle Scale</i>	1-34
INTRODUCTION	1-24	<i>Spheroid</i>	1-34
AILERONS	1-24	<i>Power OFF Flag</i>	1-34
Aileron Control	1-24	<i>Miniature Aircraft</i>	1-34
Aileron Trim	1-24	<i>Cage/Pitch Trim Knob</i>	1-34
ELEVATOR	1-24	<i>Slip/Skid Indicator</i>	1-34
Elevator Control	1-24	<i>Rate of Turn Pointer</i>	1-34
Horizontal Stabilizer Trim System	1-25	<i>Pointer Test Switch</i>	1-35
Manual Override Lever	1-25	<i>Horizontal Pointer</i>	1-35
Hydraulic Power Disconnect	1-25	<i>Vertical Pointer</i>	1-35
RUDDER	1-25	Horizontal Situation Indicator	1-35
Rudder Control	1-25	<i>Bearing Pointer</i>	1-35
Rudder Trim	1-26	<i>Lubber Line</i>	1-35
Trim Position Indicators	1-26	<i>Heading Marker</i>	1-35
WING FLAPS	1-26	<i>Course Display</i>	1-35
WING SPOILERS	1-26	<i>Power OFF Flag</i>	1-35
SPEEDBRAKES	1-27	<i>Compass Card</i>	1-35
Speedbrake Elevator Interconnect	1-27	<i>TO/FROM Arrow</i>	1-36
Emergency Speedbrake Control	1-27	<i>Course Set Knob</i>	1-36
WING SLATS	1-27	<i>Course Deviation Bar</i>	1-36
VORTEX GENERATORS	1-27	<i>Miniature Aircraft Symbol</i>	1-36
LANDING AND ARRESTING SYSTEMS	1-28	<i>Heading Set Knob</i>	1-36
LANDING GEAR	1-28	<i>Course Deviation Bar Alarm Flag</i>	1-36
Landing Gear Handle	1-28	<i>Course Pointer</i>	1-36
Emergency Landing Gear System	1-29	<i>Distance Display</i>	1-36
Undercarriage Indicators	1-29	RADAR ALTIMETER	1-36
NOSEWHEEL STEERING	1-30	RAD ALT Switch	1-37
Operation	1-30	LAWS Warning	1-37
Nosewheel Steering Switch	1-30	Self Test	1-37
BRAKING	1-31	ANGLE OF ATTACK SYSTEM	1-37
Wheelbrakes	1-31	Angle-of-Attack Indexer Lights	1-37
Park Brake	1-31	HUD AOA Display	1-38

AL 8(5)

CHAPTER 1 Cont.

THE AIRCRAFT

	PAGE		PAGE
IDENTIFICATION FRIEND OR FOE (IFF) ...	1-38	Control Stick Steering Mode	1-44
Controller	1-39	AUTOMATIC SAFETY FEATURES	1-44
<i>Master Switch</i>	1-39	Aircraft Structural Protection	1-44
<i>RAD TEST/OUT/MON Switch</i>	1-39	AFCS Temporary Overpower	1-44
<i>Mode 1, 2, 3/A and MC Switches</i>	1-39	AFCS Lateral Hydraulic Disengage	1-44
<i>Mode 1 Selector Switch</i>	1-39a	Control Stick Disengage	1-44
<i>Mode 3/A Selector Switch</i>	1-39a	PREFLIGHT TEST PROCEDURE	1-44
<i>IDENT/OUT/MIC Switch</i>	1-39a	AFCS #1 Test	1-44
<i>Mode 4 TEST/ON/OUT Switch</i>	1-39a	AFCS #2 Test	1-45
<i>CODE Switch</i>	1-39a	NORMAL IN-FLIGHT OPERATION	1-45
<i>AUDIO/OUT/LIGHT Switch</i>	1-39a	To Engage Stab Aug	1-45
<i>TEST GO, TEST/MON NO-GO</i>		To Engage AFCS	1-45
<i>and REPLY indicators</i>	1-39a	Engaging NAS-Coupled Steering	1-45
<i>ALT, KIT and ANT Status Indicators</i>	1-39a	Disengaging NAS-coupled Steering	1-45
<i>ANT TOP/DIV/BOT Switch</i>	1-39a	To Disengage AFCS	1-45
Receiver-Transmitter	1-39a	COCKPIT ENCLOSURE	1-46
<i>Mode 2 Selector Switch</i>	1-39b	INTRODUCTION	1-46
<i>An Elapsed time indicator</i>	1-39b	TA-4 CANOPY	1-46
Mode 4 Transponder Computer	1-39b	Internal Canopy Controls	1-47
Antenna	1-39b	External Canopy Control Handle	1-48
IFF Glareshield Warning Light	1-39b	Internal Canopy Jettisoning	1-48
System Interfaces	1-39b	External Canopy Jettisoning	1-48
<i>Altimeter</i>	1-39b	Underwater Canopy Jettison Relief Valve ...	1-49
<i>Tacan and Radar Warning system</i>	1-39b	A-4 CANOPY	1-49
<i>Audio</i>	1-39b	Canopy Restraint Strap	1-49
AUTOMATIC FLIGHT		Operation	1-50
CONTROL SYSTEM	1-40	External Canopy Release Handle	1-50
INTRODUCTION	1-40	Internal Canopy Jettisoning	1-50
AFCS OPERATING ENVELOPE	1-40	Canopy Jettison Safety Pins	1-50
AFCS CONTROL PANEL	1-40	External Canopy Jettisoning	1-50
<i>STANDBY Switch</i>	1-40	Underwater Canopy Jettison Relief Valve ...	1-50
<i>Stability Augmentation Switch</i>	1-40	EJECTION SEAT	1-51
<i>ENGAGE Switch</i>	1-40	INTRODUCTION	1-51
<i>Heading Select Switch</i>	1-41	Seat Adjustment	1-51
<i>Altitude Switch</i>	1-41	Shoulder Harness Inertia Reel	1-52
<i>Aileron Trim Switch</i>	1-41	Survival Pack	1-52
CONTROL STICK	1-41	Harness Release Handle	1-52
Autopilot Disconnect Button	1-41	Ejection Control Safety Handle	1-55
Sensor	1-41	Ejection Seat Stabilization System (Dart) ...	1-55
Control Stick Trim Switch	1-41	TA-4 Ejection Seat Control Selector Valve ..	1-55
AFCS MODES	1-42	Ejection Sequence	1-55
Stability Augmentation Mode	1-42	OXYGEN SYSTEM	1-57
Pitch Attitude Hold Mode	1-42	INTRODUCTION	1-57
Altitude Hold Mode	1-42	CONTROLS AND EQUIPMENT	1-57
Bank Attitude Hold Mode	1-42	Liquid Oxygen Quantity Indicator	1-57
Heading Hold Mode	1-42	Oxygen Regulator	1-57
Preselect Heading Mode	1-42	Emergency Oxygen Supply	1-58
NAS-Coupled Steering Mode	1-43	ENVIRONMENTAL SYSTEMS	1-59
		AIR CONDITIONING AND	
		PRESSURIZATION	1-59

CHAPTER 1 Cont. THE AIRCRAFT

	PAGE		PAGE
Introduction	1-59	ANTIBLACKOUT SYSTEM	1-64
Air Conditioning	1-59	ENGINE ANTI-ICING SYSTEM	1-65
Pressurization	1-62	ANGLE OF ATTACK SYSTEM HEATING ...	1-65
Air Conditioning Control Panels TA-4	1-63	RAIN REMOVAL SYSTEM	1-65
Air Conditioning Control Panel A-4	1-64	Operation	1-65
Windshield Defrost	1-64	SALT REMOVAL SYSTEM	1-65
Cockpit Fog And Snow Suppression	1-64		

FIGURES

FIGURE	PAGE	FIGURE	PAGE
1-1 Principal Dimensions	1-2	1-25 RAD ALT Switch	1-37
1-2 Airframe Major Components	1-3	1-26 Index Conditions	1-38
1-3 General Layout - Cockpit	1-4	1-27 C-10009 IFF controller	1-39
1-4 Fuel Shutoff Control Lever and Linkage .	1-6	1-27b RT-1157B/APX 100(V)	1-39b
1-5 A-4 Engine Control Panel	1-6	1-28 AFCS Control Panel	1-40
1-6 TA-4 Engine Control Panel	1-6	1-29 Control Stick	1-41
1-7 Engine Instrument Panel	1-8	1-30 AFCS Steer Selection	1-43
1-8 Typical CG Travel: Gear and Flaps Down	1-11	1-31 HUD Heading Scale with	
1-9 Fuel Quantity, Flow Indicator &		AFCS STEER Caret	1-43
INT/EXT Switch	1-13	1-32 Canopy Control System -	
1-10 Fuelling Check Switch And		Normal Operation	1-46
Drop Tanks Fuelling Switch	1-14	1-33 Canopy Unlock Warning	
1-11 Air Refuelling Control Panel	1-15	Light Assemblies	1-47
1-12 RH Wedge Panel	1-18	1-34 Canopy Jettison Initiator (M99)	1-48
1-13 DC Converter	1-18	1-35 Canopy Control System -	
1-14 Ext Lighting Control Panel	1-20	Normal Operation	1-49
1-15 Internal Light Panel	1-21	1-36 ESCAPAC 1G-3 Ejection Seat	1-53
1-16 Warning Lights Glareshield	1-22	1-37 Parachute (Typical)	1-54
1-17 Trim Indicators	1-26	1-38 Ejection Seat Control Selector Valve ...	1-56
1-18 Landing Gear Control		1-39 Oxygen Regulator	1-57
Handle and Linkage	1-28	1-40 A-4 Air Conditioning and	
1-19 Undercarriage Indicator Panel	1-29	Pressurization System	1-60
1-20 Spoiler and NWS Switches	1-30	1-41 TA-4 Air Conditioning and	
1-21 Park Brake Switch	1-31	Pressurization System	1-61
1-22 Drag Chute Switch	1-32	1-42 Cockpit Pressurization Chart	1-62
1-23 ADI Indicators and Controls	1-35	1-43 A-4 & TA-4 Air-conditioning	
1-24 HSI Indicators and Controls	1-36	Wedge Panels	1-63
		1-44 Personal Services Panel (PSP)	1-65

TABLES

TABLE	PAGE	TABLE	PAGE
1-1 Fuel Transfer Rates	1-10	1-4 Glareshield Warning Light Indications ..	1-22
1-2 Fuel Tank Transfer Rates	1-11	1-5 AOA Cruise Control	1-38
1-3 Warning Light Indications	1-21	1-6 AFCS Engage Modes	1-42

AL 7(0)

CHAPTER 1

THE AIRCRAFT

GENERAL DESCRIPTION

INTRODUCTION

1.1 The A-4 is a single engine, single seat, light weight attack aircraft, with full air to ground and limited air to air combat capabilities. The TA-4 is a two seat (tandem) version and performs a secondary role as a trainer. The T/A-4 is powered by a Pratt & Whitney J52-P-8B/C turbojet engine. The aircraft has a modified delta planform wing and tail, and features aerodynamically operated leading edge slats and hydraulically powered flaps, spoilers, and speedbrakes. All flight control surfaces are powered by two independent hydraulic systems with an ability to revert to manual control should both systems fail. The NAS includes an Inertial Navigation Unit, Multimode Radar, Computer Interface Unit, Display Processor; and features a HUD with associated Up Front Controller; two multi function Display Units and HOTAS controls. Basic armament consists of two wing root mounted 20mm cannon, and five underwing pylons that can carry a variety of stores.

DIMENSIONS

1.2 The principal three point dimensions of the aircraft are as follows:

- | | | | |
|----|---------------|------|-------------------|
| a. | Length: | A-4 | 41 feet 3 inches |
| | | TA-4 | 43 feet 7 inches |
| b. | Wing Span: | | 27 feet 6 inches |
| c. | Height: | A-4 | 14 feet 10 inches |
| | | TA-4 | 15 feet 7 inches |
| d. | Tail Span: | | 11 feet 4 inches |
| e. | Basic Weight: | A-4 | 12000lb |
| | | TA-4 | 13000lbs |
| f. | Max AUW: | | 24500lbs |

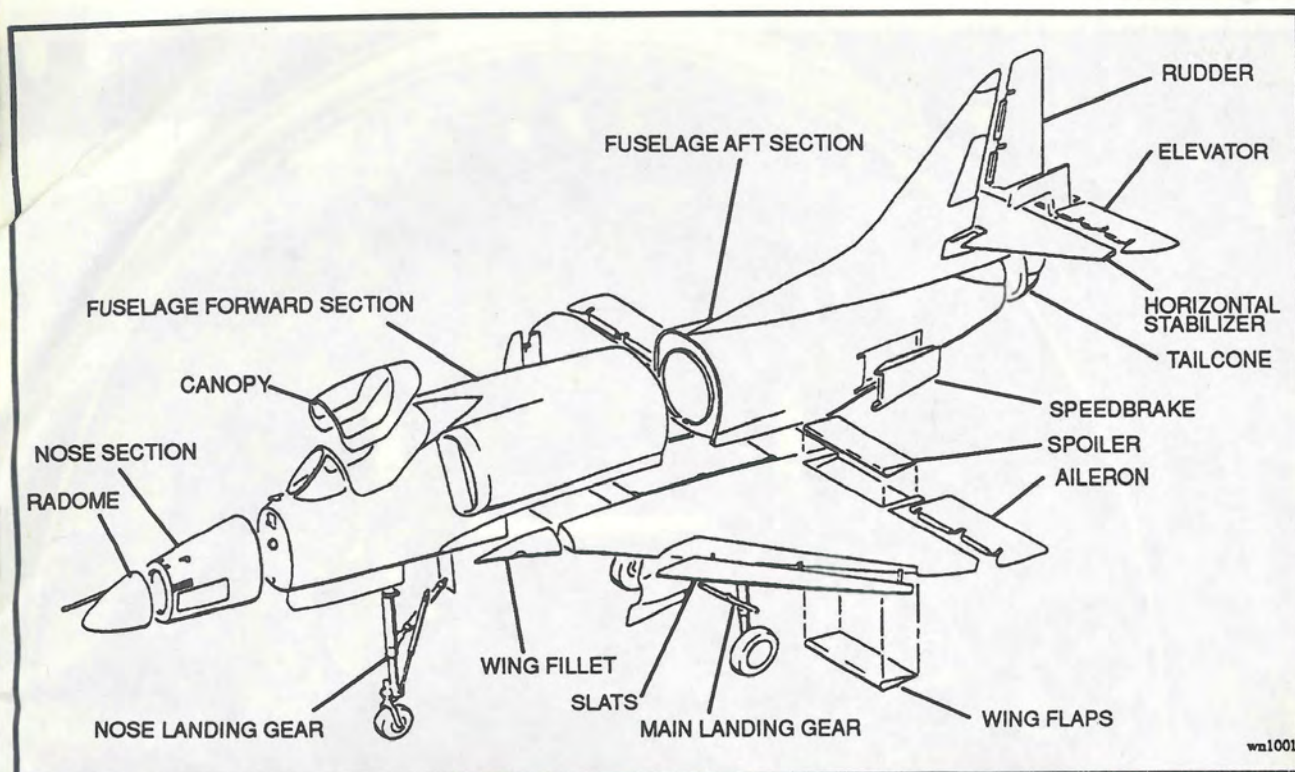


Figure 1-2 Airframe Major Components

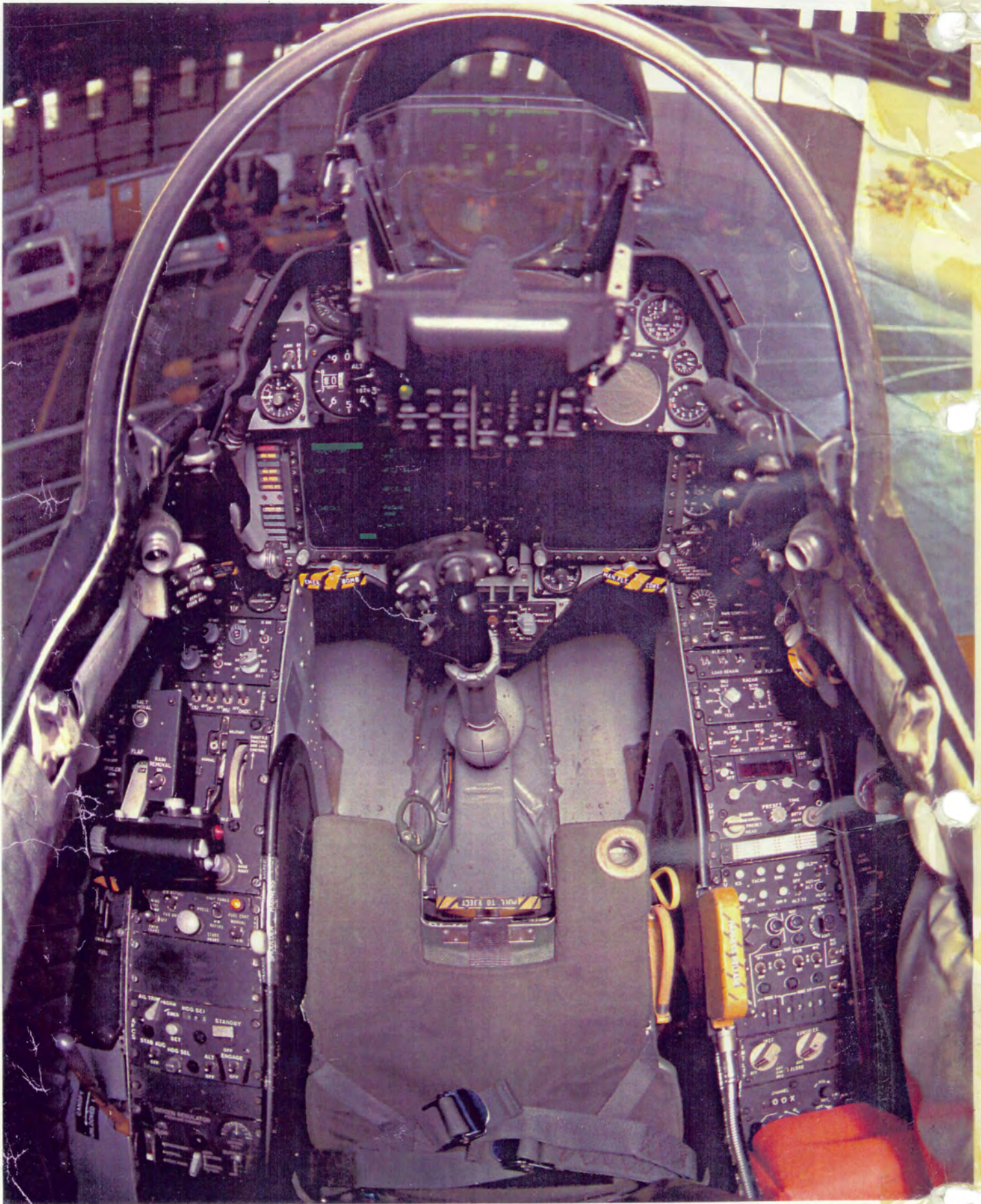


Figure 1-3 General Layout – Cockpit

PROPULSION SYSTEM

ENGINE

1.3 The P&W J52-P-8B/C (9300 pounds sea level static thrust rated) turbojet is a continuous flow gas turbine engine consisting of a split 12 stage axial flow compressor, a unit can-annular combustion chamber, and a split 2 stage turbine. The engine has three major sections: the compressor section, the turbine section, and the accessory section.

1.4 The axial flow compressor consists of a five stage low pressure unit and a seven stage high pressure unit. The low pressure unit is connected by a through shaft to the second stage turbine rotor. The high pressure unit is connected independently by a hollow shaft to the first stage turbine rotor. The rpm of the high pressure rotor (N₂) is governed by the engine fuel control: whereas the low pressure rotor rpm (N₁) is completely independent and is entirely a function of the pressure drop across the turbines.

1.5 The engine has nine combustion chambers, two of which contain spark igniters for engine starting. The anti-icing air system, compressor airbleed system, internal airbleed system, lubrication system, pressure oil system, scavenge oil system, oil breather system, fuel system, ignition system, and fuel heater are also included as part of the engine.

Compressor Airbleed System

1.6 The compressor airbleed system vents low pressure compressor air overboard as necessary to prevent overloading of the high pressure compressor unit.

CAUTION

Covering or clogging of the engine bleed static port on the left side of the forward fuselage can cause compressor chugs and stalls and/or loss of thrust.

Ignition

1.7 The engine ignition system consists of two spark igniters, an ignition timer, and dual 20 joule ignition units. The spark igniters are located in the two combustion chambers at the 4 and 8 o'clock positions. For engine starting, the timer energizes the high power ignition unit which powers the 20 joule igniters for a 30 to 45 second firing cycle. A micro switch activated by movement of the throttle outboard from the OFF position energizes the ignition timer.

Starter

1.8 The engine is started on the ground by a pneumatic starter driven by compressed air from a mobile Gas Turbine Compressor.

ENGINE FUEL SYSTEM

1.9 The function of the fuel system is to supply and regulate the fuel to the combustion chambers at pressures and flows required by engine airflow at all operating altitudes and temperatures. The system has two major components: the engine fuel pump and the fuel control unit.

Fuel Pump

1.10 The engine fuel pump consists of a centrifugal boost stage and a high pressure single gear stage. The boost impeller serves to increase pressure and eliminate pump cavitation in the gear stage. A replaceable 40 micron cartridge filters the fuel as it passes between the boost and gear stages. A filter bypass valve, in parallel with the filter, will bypass fuel if the filter becomes clogged. Excess fuel pressure will be relieved by a relief valve set at approximately 90 psi above maximum expected discharge pressure. A vapour return to the fuselage fuel cell is also part of the engine fuel pump.

Fuel Control Unit

1.11 The engine Fuel Control Unit is a hydromechanical control unit that schedules the fuel flow to ensure that maximum acceleration and deceleration rates can be obtained with satisfactory engine operation. The FCU automatically regulates the fuel flow to maintain stable engine operation during normal flight conditions and manoeuvres, thus preventing compressor stalls, excessive temperatures, or flameouts.

Manual Fuel Shutoff Control

1.12 The fuel system incorporates a manually operated (not interconnected) fuel shutoff control lever in both cockpits which is located outboard of the left hand console. This lever has two positions: **NORMAL** and **EMER OFF**. The **EMER OFF** position prevents fuel flowing to the engine fuel control system. A spring loaded lift type guard is provided to prevent inadvertent movement of the lever to **EMER OFF**.

NOTE

To ensure complete fuel shutoff, the control lever must be moved fully into the **EMER OFF** detent.

Engine shutdown using this control lever will take approximately 30 seconds at idle power and as few as 4 seconds at military.

AL 5(0)

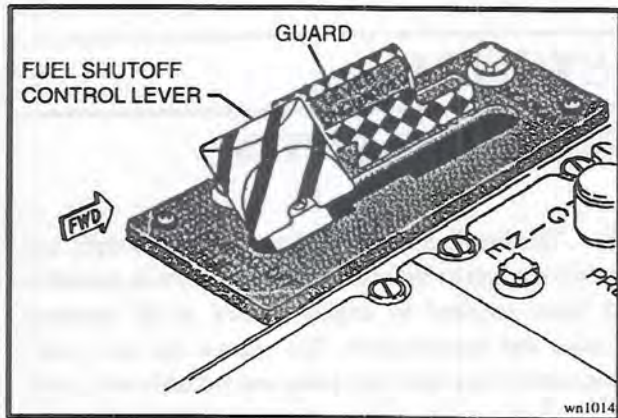


Figure 1-4 Fuel Shutoff Control Lever and Linkage

ENGINE CONTROLS

Engine Control Panel

1.13 The engine control panel is located just behind the throttle and contains all other controls necessary for engine operation, plus the fuel management switches. The following switches are common to both A-4 and TA-4 front cockpit panels:

- a. **WING FUEL DUMP, OFF** and **EMER TRANS.**
- b. Drop tanks **OFF, PRESS** and **AIR REFUEL** (labelled **FLIGHT REFUEL** on the TA-4).
- c. Engine **START, ABORT** knob.
- d. Fuel control **MANUAL, PRIMARY**.
- e. Manual fuel control warning light.

1.14 The A-4 has an additional switch, the Air Refuel **NORMAL, FUSELAGE ONLY** switch, which is not provided on the TA-4. Instead, this function is provided on the TA-4 by a Fuel Transfer **NORMAL, BYPASS** switch which is positioned above the forward right hand console next to the white floodlights knob.

1.15 The aft TA-4 engine control panel is identical to the forward TA-4 panel except that the drop tanks switch has only two positions: **OFF** and **PRESS**, instead of the three positions provided in the forward cockpit.

NOTE

The aft drop tank switch must be 'OFF' to allow normal operation of the forward drop tank switch.



Figure 1-5 A-4 Engine Control Panel



Figure 1-6 TA-4 Engine Control Panel

Fuel Control Switch

1.16 A two position fuel control switch on the engine control panel is used to select the mode of operation of the engine fuel control unit.

- a. **PRIMARY** – The Fuel Control Unit senses inlet air temperature and pressure, burner pressure, high pressure compressor speed (N₂), and throttle position, and provides full fuel scheduling throughout the flight envelope of the aircraft.
- b. **MANUAL** – The Fuel Control Unit compensates for pressure altitude and airspeed only. All fuel metering to the engine is accomplished by direct movement of the throttle therefore, all power changes must be made with care, not only to remain within EGT limits, but also to avoid a flameout from the possible inability of the engine to parallel (in speed) the rapidly changing fuel flow during quick accelerations and decelerations. The engine fuel control operation may be changed from **PRIMARY** to **MANUAL** at any altitude. If airspeed, at the time of switchover, is above 225 KIAS, selection of **MANUAL** may be made at any throttle setting from **IDLE** to **MILITARY**.

NOTE

If airspeed is below 225 KIAS, rpm must be above 70 percent prior to switchover.

AL 8(0)

1.17 The switchover to the manual fuel system may be accompanied by a minor surge in engine speed and EGT. Switchover from **MANUAL** to **PRIMARY** fuel control should be accomplished between 80 to 85 percent rpm.

CAUTION

A minimum in flight engine rpm of 70 percent should be maintained to preclude possible flameout.

NOTE

Complete loss of electrical power precludes switching the fuel control from the position selected.

Manual Fuel Control Warning Light

1.18 The manual fuel control warning light, located on the engine control panel, comes on when the fuel control unit has shifted to the manual mode of operation. The light indicates the position of the emergency transfer valve which directs the fuel to either the primary or manual fuel control system. Regardless of the position of the fuel control switch, the emergency transfer valve is kept in the manual fuel control position by spring load, until overcome by engine driven fuel pump pressure. Consequently, the light will be on during normal engine starts until fuel pressure shifts the transfer valve to the **PRIMARY** position, normally at 5 to 10 percent rpm, but the light must be out by 25 percent rpm. The light will also come on shortly after engine shutdown indicating a shift to the manual mode upon loss of fuel pressure.

Engine Starter Switch

1.19 Actuation of the starter is controlled by the engine starter switch on the engine control panel and is labelled **START-ABORT**. When the switch is depressed to **START**, the starter air supply solenoid valve opens, allowing compressed air from the gas turbine compressor to rotate the starter. A holding relay retains the switch in the **START** position. When engine speed reaches approximately 50 percent rpm, a centrifugal switch in the starter opens, allowing the engine starter switch to pop up,

thus stopping the air supply to the starter. Manually pulling out the engine starter switch will also stop the starter air supply.

Throttle

1.20 The throttle, located on the left console, has the following marked positions: **OFF**, **IGN**, **IDLE**, **NORMAL**, and **MILITARY**. The **OFF** position closes a fuel cutoff valve in the fuel control unit, stopping fuel flow to the engine fuel nozzles. The **IGN** position actuates the ignition timer microswitch when the throttle is moved outboard from the **OFF** position. The **IDLE** position is detented to prevent inadvertent movement of the throttle to the **OFF** position. The **NORMAL** position covers the operating range of the engine. Maximum thrust should be developed from the engine at **MILITARY**, but rpm will vary with ambient air temperature and airspeed. The throttle grip contains switches that provide control over various systems enabling hands on throttle control. The throttle friction wheel is on the panel inboard of the throttle. Rotating the friction wheel forward increases the throttle friction. The throttle in the rear cockpit of the TA-4 is linked in tandem to the engine fuel control unit. The rear cockpit throttle positions are labelled: **OFF**, **IGN**, **IDLE**, **NORMAL**, and **MILITARY**. The **OFF** position is labelled to indicate the position but does not shut down the engine. Engine shutdown can only be accomplished in the rear cockpit by closing the manual fuel shutoff lever. The **IGN** position actuates the ignition timer microswitch when the throttle is moved outboard. The **IDLE** position is not detented and is used only to show the range between **IDLE** and **NORMAL**. The **NORMAL** position indicates the operating range of the engine. The rear cockpit throttle does not have a throttle friction wheel.

WARNING

*When selecting throttle to **IDLE**, especially in conjunction with deployment of speedbrakes, extreme care must be taken to avoid application of outboard pressure on the throttle. This action will prevent inadvertent selection of throttle to **OFF** and subsequent engine flameout.*

AL 8(0)

ENGINE INSTRUMENTS

Exhaust Gas Temperature Indicator

1.21 The EGT indicator located on the engine instrument panel, indicates in degrees centigrade, the temperature of the exhaust gases immediately downstream of the turbine assembly. The range of indications is from 0 to 1000 degrees centigrade. The EGT indicator operates independently of aircraft electrical power and functions whenever the engine is running.

NOTE

High rates of roll, or positive and negative accelerations may cause the EGT indicator to give erroneous indications. However, upon return to stabilized flight, readings will return to normal.

Tachometer

1.22 A tachometer located on the Engine instrument panel (Figure 1-7), indicates the speed of the high pressure compressor rotor (N_2) as a percentage of rpm, 100 percent equating to 12,052 rpm. The tachometer operates independently of aircraft electrical power.

Engine Pressure Ratio Indicator

1.23 An EPR indicator, located on the Engine instrument panel (Figure 1-7), indicates the ratio between the second stage turbine discharge pressure (P_{t7}) and the aircraft pitot air pressure (P_{t2}). The instrument is calibrated from 1.2 to 3.4 units. A knob on the lower left hand side of the instrument operates a digital counter and simultaneously moves an index along the perimeter of the dial. The knob is rotated to set the minimum acceptable engine pressure ratio for takeoff on the digital counter. EPR indications are not available on emergency generator.

Fuel Flowmeter

1.24 A fuel flowmeter indicator located on the lower right hand instrument panel (Figure 1-9), shows engine fuel consumption in pounds per hour. The portion of the dial between 300 and 5000 pounds per hour is divided into 100 pound increments. Above 5000 pounds per hour, the dial is marked into 1000 pound increments. Flow rates between 0 and 300 pounds per hour will be indicated as 300 pounds per hour.

OIL SYSTEM

Introduction

1.25 The engine lubrication system is a self contained, high pressure system which supplies lubrication to the main engine bearings and to the accessory drives. Pressure oil delivered by the engine driven oil pump is cooled by means of an oil cooler prior to entering the bearing compartments. The oil cooler is a heat exchanger employing the fuel flowing from the engine fuel control to the fuel nozzles as a coolant. A scavenge system returns oil withdrawn from the bearing compartments and the accessory drive gear box to the oil tank. A breather system connects the individual bearing compartments and oil tank with the breather pressure relief valve. The breather pressure relief valve vents overboard on the right hand side of the rear fuselage. The maximum oil consumption is 0.28 US gallon (approximately 1 litre) per hour.

Oil Pressure Indicator

1.26 The oil pressure indicator located on the engine instrument panel (Figure 1-7) shows engine oil pressure. Oil pressure indications are available on emergency generator.



Figure 1-7 Engine Instrument Panel

AL 8

Low Oil Pressure Light

1.27 The OIL PRESS caption, mounted in the warning light panel, is connected to the MASTER CAUTION system, and will illuminate when engine oil pressure falls below 32 psi.

Oil Quantity Indicator / Switch

1.28 An oil quantity indicator/switch, labelled **OIL LOW**, is mounted on the upper right hand side of the instrument panel. The oil low indicator light automatically comes on when the engine oil tank reaches a critically low engine oil level of 20 percent or less of capacity. Oil servicing is required if the oil low light is not on but comes on when the switch is pressed. This indicates that the engine oil tank contains over 20 percent but less than 80 percent of capacity.

NOTE

After securing the engine, oil seeps past the high pressure oil pump into the accessory gear case. For this reason, an oil quantity check should be made within 30 minutes after engine shutdown, or when the engine has run for 8 minutes or longer at 75 percent or higher rpm and the scavenge pump has returned the oil to the tank. False indications may be obtained if the oil quantity check is made during taxi or takeoff because of engine acceleration disrupting the oil level.

The oil quantity light may erroneously indicate low oil quantity momentarily during periods of takeoff acceleration. A decision to abort must be tempered by airspeed at the time of occurrence.

FUEL SYSTEM

INTRODUCTION

1.29 The internal fuel supply is carried in two tanks, the integral wing tank and the fuselage tank. These tanks can be serviced through two gravity fuel tank fillers or a singlepoint pressure fuelling system. Three external drop tanks can be carried to increase the total fuel quantity by 1000 US gallons. These tanks can be refuelled through the aircraft's single point pressure refuelling system or individually gravity fuelled. Fuel is transferred from the drop tanks to the wing tank by utilizing engine bleed air. An engine bleed air driven fuel pump transfers wing fuel to the fuselage tank, from where it is delivered under pressure to the engine driven fuel pump. Emergency wing fuel transfer may be accomplished by pressurizing the wing tank with engine bleed air.

FUEL TANKS

Internal Tanks

1.30 Internal tanks comprise an integral wing tank and a self sealing fuselage tank mounted between the cockpit and the engine bay. The fuselage tank contains the control valve for regulation of fuel being transferred from the wing, and the fuel boost pump which delivers fuel to the engine driven fuel pump. In the A-4 a sump is incorporated within the fuselage cell to ensure adequate supply of fuel to the booster pump during negative G conditions. In the TA-4 a standpipe housing over the booster pump ensures a flow of fuel to the fuel pump regardless of attitude and during manoeuvres involving negative G loads and inverted flight. Both the wing and fuselage fuel tanks are vented. The vent system exit is located in front of the fuel dump mast, and is designed to provide positive pressure in the fuel vent system to reduce the amount of collapse of the self sealing fuselage tank as it empties. Both tanks incorporate provisions for gravity fuelling, pressure fuelling and defuelling, and water and sediment drainage.

External Tanks

1.31 Jettisonable drop tanks may be carried either singly or in combination. The inboard and centreline external stores racks will accommodate either 150 or 300 US gallon drop tanks. A 300 US gallon air refuelling store or a 400 US gallon drop tank may be accommodated on the centreline rack only. All drop tanks are vented and have provisions for gravity fuelling, pressure fuelling and bleed air pressurization to effect fuel transfer to the integral wing tank.

FUEL TRANSFER

Wing Tank Transfer

1.32 An engine bleed air driven transfer pump is located in the wing tank which transfers wing tank fuel to the fuselage tank. Since the pump operates continuously, a fuel transfer shut off valve placed in the fuselage tank stops the transfer of fuel when the fuselage tank is full. A fuel transfer failure FUEL TRANS light is located on the warning panel and illuminates when wing tank fuel transfer pressure drops below $2 (+1/4, -1/8)$ psi. At idle there may be insufficient fuel pressure to turn off the FUEL TRANS light. A steady light, when engine rpm is above 70 percent, indicates possible fuel transfer pump failure or wing tank fuel depletion. Inflight manoeuvring may cause the pump to become temporarily unported, thereby inducing intermittent flashing of the FUEL TRANS light.

NOTE

With fuel transfer shutoff valve failure, the FUEL TRANS light may not illuminate.

Drop Tank Transfer

1.33 Fuel transfer from the drop tanks to the integral wing tank or fuselage tank is accomplished by pressurizing the drop tanks with engine compressor bleed air regulated to 10 psi. Placing the drop tanks transfer switch, on the engine control panel in the PRESS position opens a solenoid operated air shutoff valve, which directs engine compressor bleed air to the drop tanks. Once the tanks are pressurized, the flow of fuel from the drop tanks to the wing tank is controlled by the dual float pilot valve in the wing tank, which stops the transfer of fuel when the wing tank is full or allows it to continue when space is available. If the wing is full and the fuselage tank is not (as in the case of wing tank transfer pump failure), drop tank fuel will flow directly to the fuselage tank. To discontinue fuel transfer from the drop tanks, place the drop tanks switch in OFF. This energizes the drop tank air shutoff valve, thereby closing the valve and stopping fuel transfer. In the case of an electrical failure the drop tank air shutoff valve opens, providing immediate and automatic transfer of drop tank fuel as wing tank space permits. To prevent drop tank pressurizing air from being exhausted overboard through the drop tank vent, each drop tank is equipped with a combination float and diaphragm vent shutoff valve. This valve acts to close the drop tank vent when the tank is full or pressurizing air is introduced. The maximum transfer rate from the drop tanks to the fuselage tank is 9500 Pounds Per Hour (PPH) with two wing drop tanks and 14,000 PPH with three drop tanks installed.

CAUTION

Unless the **DROP TANK FUELLING** switch in the rear engine compartment is in the **OFF** position, fuel transfer from the drop tanks is not possible in the air, except by deploying the emergency generator.

Drop tank pressurization must be selected to **OFF** prior to manoeuvres that may result in a departure from controlled flight or manoeuvring flight resulting in high roll rates or negative G. A momentary block of the pressure vent valve could cause overpressurization of the wing tank resulting in structural damage.

Where fuel is critical, drop tanks should be left pressurized until 1500 lbs external fuel is indicated to ensure all external tanks are feeding.

NOTE

A noticeable thumping may be experienced during the latter stages of drop tank transfer.

Venting of fuel through the wing tank vent mast may occur in the latter stages of drop tank transfer. Placing the drop tank switch to **OFF** will stop the venting. Drop tanks should be repressurized only when the wing tank is not completely full.

The drop tank transfer switch should be selected to **OFF** as a matter of course when all fuel has been transferred from the drop tanks.

Indication of fuel transfer may take as long as 10 minutes if activated with less than 400 lbs of fuel or less remaining in each drop tank.

Emergency Transfer

1.34 A **WING FUEL** switch located on the engine control panel provides for the emergency transfer of wing fuel by utilizing wing tank pressurization. Moving the switch to the **EMER TRANS** position closes the wing tank pressure and vent valves allowing engine compressor bleed air to pressurize the wing tank to 6 psi. Fuel is then transferred to the fuselage tank through the pressure fuelling line. If normal transfer failure was caused by a failure of the transfer pump, emergency transfer fuel will also flow through the regular transfer line as well as the pressure fuelling line to the fuselage tank.

CAUTION

When the **WING FUEL** switch is in the **EMER TRANS** position and fuel covers the wing tank fuel vent outlet, overpressurization of wing is possible. The dump valve will open at 8.5 psi, relieving the pressure but resulting in uncommanded fuel dumping through the dump mast. This condition can exist during negative G flight or when aircraft is in nosedown attitude.

Refer to Chapter 4 for limitations applicable to flight with the wing tank pressurized.

1.35 The inboard rack fuel lines have a non return valve, that prevents fuel under 6 psi pressure from being forced into the drop tanks when **EMER TRANS** is selected. To enable fuel to be transferred from the wing to the Buddy Store, the centre line rack fuel plumbing lacks that non return valve. To prevent transfer of wing tank fuel to the centreline drop tank, where it would be unavailable for immediate transfer, the drop tanks must be pressurized prior to the **EMER TRANS** being selected. Air pressure in the centre drop tank will prevent the flow of fuel from the wing down into the centre line tank.

NOTE

External fuel transfer may not be possible with the emergency fuel transfer switch activated.

Emergency Fuel Transfer is available on emergency generator.

Fuel Transfer Rates

1.36 Refer to Table 1-1. The basis of this table comes from fuel lab tests using JP-5 fuel and shows Air Turbine Pump Fuel Transfer from Wing to Fuselage Tank.

Table 1-1 Fuel Transfer Rates

ALT	MACH	Gallons/Hr	Pounds/Hr
SL	V min	1260	8568
15,000	V min	1200	8160
25,000	V min	1200	8160
35,000	V min	1080	7344
SL	V max	2880+	19,584+
15,000	V max	2880	19,584
25,000	V max	2400	16,320
35,000	V max	1920	13,056

1.37 Refer to Table 1-2. Drop tank fuel transfer rates apply from Sea Level to 40,000 feet for all flight regimes except idle descent.

AL 7(0)

Table 1-2 Fuel Tank Transfer Rates

External Drop Tanks To Internal Fuel Tanks	Pounds / Hour
Wing drop tanks (two)	9500
Centreline drop tank	5500
Two wing/centreline drop tank combination	14,000

Wing Tank/ Air Refuelling Store	Gallons / Minute	Pounds / Minute
Wing tank to Buddy Store	80 to 100	544 to 680
Buddy store to wing tank	14 to 18	95 to 122.4
Buddy store to receiver aircraft	180	1224

Emergency Fuel Transfer	Gallons / Minute	Pounds / Hour
Wing to fuselage tank	21	8568

Fuel Dump Rates	Gallons / Minute	Pounds / Minute
Wing tank	100+	680+
Air refuelling store	100	680

Fuel Consumption Effects On Aircraft Centre Of Gravity

1.38 Drop tank fuel consumption has the least effect on centre of gravity movement. The centre of gravity will move approximately one percent Mean Aerodynamic Chord (MAC) forward as the drop tank fuel goes from full to empty. Aircraft normal fuel scheduling maintains the fuselage tank at; 1400-1500lbs (A-4), and 600-700lbs (TA-4), by transfer of first drop tank fuel and then wing tank fuel. Wing tank fuel consumption causes the centre of

gravity to move forward until the wing tank is empty. The centre of gravity will move forward approximately six percent MAC as wing tank fuel goes from full to empty. The aircraft will be at its most forward centre of gravity for a given configuration when only the fuselage tank is full. Fuselage tank fuel consumption causes the centre of gravity to move rearward. The centre of gravity will move rearward approximately seven percent MAC A-4, three percent MAC TA-4, as the fuselage tank fuel level drops from normal to empty. Refer Figure 1-8.

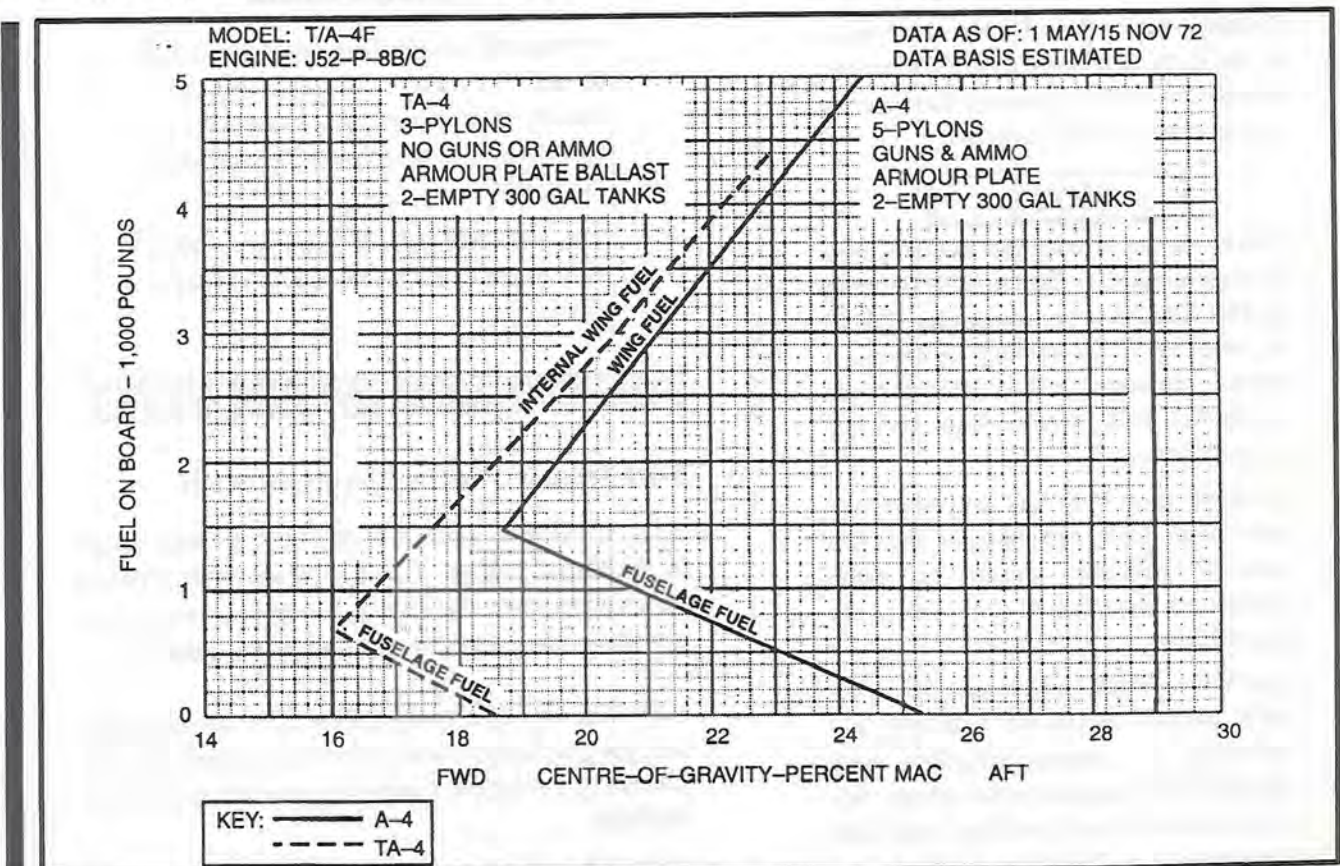


Figure 1-8 Typical CG Travel: Gear and Flaps Down

AL 5(0)

Wing Tank Fuel Dump And Pressure Relief Valve

1.39 A fuel dump and pressure relief valve is installed in the wing tank to prevent overpressurization of the wing tank and to allow wing tank fuel to be dumped overboard. The pressure relief function fully opens the dump valve when pressure within the wing reaches 8.5 to 9.0 psi. When opened in this manner, the dump valve will not reset until pressure within the wing decreases to about 4 psi. Normal (pilot selected) function of the dump valve is accomplished by placing the wing tank fuel dump switch, located on the engine control panel, in the guarded **DUMP** position. This will allow wing fuel to flow by gravity out the dump mast, located on the right main landing gear fairing, at the rate of approximately 660 lbs per minute.

CAUTION

Dumping fuel above the freezing level may result in the dump valve freezing open. Fuel dump will then continue until the wing tank fuel is depleted or descent is made below the freezing level.

After each valve operation a minimum of 2 minutes must be allowed prior to reactivating the dump switch. This ensures all fuel drains from the diaphragm cavity, otherwise damage to the diaphragm may result.

If emerg trans is selected inadvertently prior to fuel dump, this may lead to the wing fuel dump valve sticking open and dumping the entire contents of the wing tank.

NOTE

Maximum rate of wing fuel dumping may be accomplished, in the TA-4, by selecting **EMER TRANS** in one cockpit and **DUMP** in the other. This should not be done as a normal procedure, and if utilized in an emergency, both switches must be **OFF** prior to landing.

While dumping wing tank fuel, select drop tank press **OFF** and monitor the fuel quantity indicator closely to avoid inadvertent dumping of fuel below the desired level.

The **WING FUEL** switch must be in the **OFF** position during air refuelling, hot refuelling or ground refuelling with electrical power applied to the aircraft. This will prevent dumping of fuel overboard through the wing fuel dump valve.

Scupper Drain (Gang Drain)

1.40 A mast, located behind the rear engine compartment door, drains fuel from various aircraft and engine areas. Any fluids seen venting from this mast, other than on shut down, may indicate a serious malfunction or leak and is cause for immediate landing and investigation.

A-4 AIRCRAFT ONLY

Air Refuel Norm / Fus Only Switch

1.41 The **AIR REFUEL** switch is located on the engine control panel in the A-4 only. When the switch is placed to **FUS ONLY** position during air refuelling, fuel will only flow to the fuselage tank. The switch is normally used when the receiver aircraft has wing damage to prevent fuel from entering a damaged wing, thus averting a fuel loss/fire hazard condition. Air refuelling of the fuselage and drop tanks (bypassing the wing tank) is possible by placing the **DROP TANK** switch in the **AIR REFUEL** position, in addition to placing the **AIR REFUEL** switch in the **FUS ONLY** position. Transfer of fuel directly from the drop tanks to the fuselage tank is possible by selecting **FUS ONLY** and pressurizing the drop tanks.

CAUTION

If drop tank transfer lines, which are routed through the wing tanks, are damaged, transfer of drop tank fuel or attempted air refuelling of drop tanks could constitute a fire hazard.

The **AIR REFUEL NORM/FUS ONLY** switch is operable on emergency generator power.

TA-4 AIRCRAFT ONLY

Fuel Transfer Normal/Bypass Switch

1.42 There is no Air Refuel **NORM/FUS ONLY** switch in the TA-4. Instead, a **FUEL TRANSFER BYPASS** switch is provided for use during normal fuel transfer or air refuelling, when it is required to bypass the wing tank.

1.43 The fuel transfer bypass switch is mounted above the right hand console in the TA-4 front cockpit only. It is covered by a red guard to prevent inadvertent selection of **BYPASS**.

AL 8(7)

Fuel Boost Pump

1.44 An AC electrically driven fuel boost pump is submerged in the fuselage tank. Operation of the fuel boost pump is automatic whenever the aircraft electrical system is energized by the main generator, or by external power through the ground test switch. In the event of main generator failure, the fuel boost pump will be inoperative and will remain inoperative even though the emergency generator is deployed.

Fuel Boost Pressure Indicator

1.45 Loss of fuel boost pressure is indicated by a **FUEL BOOST** light located on the warning light panel. The warning light illuminates whenever fuel boost pressure falls below 4 psi and will go out as pressure increases above 6 psi.

FUEL QUANTITY INDICATING SYSTEM

1.46 The Fuel Quantity Indicating System consists of capacitance type fuel quantity probes, a fuel quantity indicator, a LOW LEVEL switch, a FUEL QUANTITY TEST switch, a low fuel level warning light, and associated wiring. The wing tank contains six fuel quantity probes. Each external fuel tank and the fuselage tank contain one fuel quantity probe. The wing and fuselage probes are wired into the Fuel Quantity Indicator that indicates the total quantity of fuel remaining in the internal tanks. Internal and external fuel tanks quantity is checked by selecting the FUEL QUANTITY switch to the appropriate position.

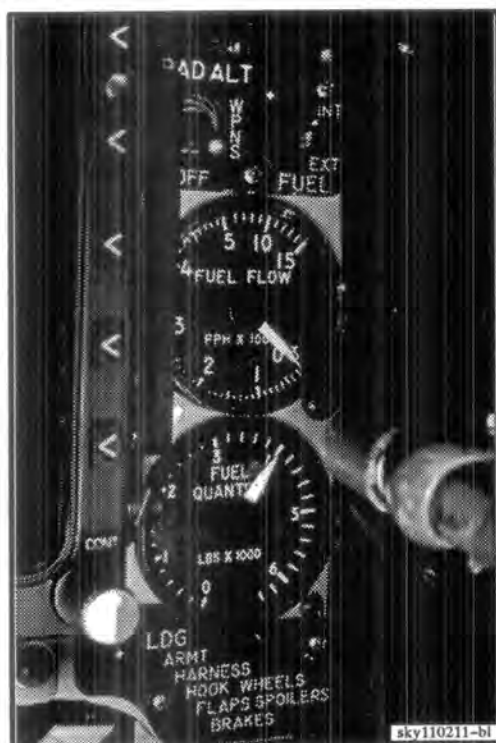


Figure 1-9 Fuel Quantity, Flow Indicator & INT/EXT Switch

Fuel Int-Ext Switch

1.47 A switch labelled **INT-EXT** is located on the instrument panel for checking external fuel load. External quantity will be indicated when the switch is moved to the **EXT** position. This switch should normally be left in the **INT** position to confirm proper flow to the wing and fuselage tanks.

Fuel Quantity Indicator

1.48 The fuel quantity indicator, located on the instrument panel, indicates the total fuel available in pounds. The range of indication is from 0 to 6400 pounds. Indicated airspeed for most accurate fuel reading is 250 KIAS at approximately 80 percent rpm in level flight. The fuel quantity indicator gauge may be tested by the Press To Test button on the instrument panel. When the test button is depressed, the Fuel Quantity Indicator pointer will rotate in an anti-clockwise direction. When the test button is released, the pointer will return to the original indication if all units of the fuel quantity measuring circuit are functioning properly.

NOTE

Manoeuvring or accelerated flight causes erroneous fuel quantity indications.

The fuel quantity measurement is performed by capacitance probes, which measure mass of fuel. For external quantities, the fuel quantity indicating system will over-read when external tanks are between full and half, and under-read when between half and empty. The differences are minor.

In the event of dual converter failure, no DC power will be available to the fuel quantity control unit. As a result, the fuel quantity indicator will indicate only fuel available in the fuselage fuel cell (fuel available in the wing tank will not be included). This fuel indication will be approximately 1600 pounds, (A-4), 650 pounds, (TA-4), with wing tank fuel transferring correctly. As total usable fuel becomes less than the fuselage tank capacity, the correct fuel quantity will be indicated.

AL 11(8)

Low Fuel State Warning Indicator

1.49 (Pre-NZM/213.005/78 and NZM/213.005/85.) The low fuel warning ladder light indicates a low fuel condition. It is *not* connected to the Master Caution circuit.

1.49a (Post-NZM/213.005/78 and NZM/213.005/85.) The low fuel warning ladder light indicates a low fuel condition. It is connected to the Master Caution circuit.

1.49b The low fuel warning ladder light will illuminate if either of the following conditions exist:

- a. Internal fuel quantity has decreased below 1100 pounds.
- b. Fuselage tank quantity has dropped below the two thermistor sensors located at the 170 gallon level (A-4), and 82 gallon level (TA-4), (approximately 1100 and 550 pounds respectively). This situation could occur due to a malfunction of the wing tank transfer system, or failure or mismanagement of the drop tank transfer system. In addition, the low level sensors cause the reading of any remaining wing tank fuel to be dropped out, indicating to the pilot the quantity of usable fuselage fuel that remains.

NOTE

There are two separate thermistor circuits; lower and upper. Both are tested via the master test switch and an explanation of this test is on paragraph 1.103.

1.50 The low fuel state warning light is accurate in stable flight conditions between 8 degrees nose up and 12 degrees nose down.



Figure 1-10 Fuelling Check Switch And Drop Tanks Fuelling Switch

SINGLE POINT FUELLING AND DEFUELLING SYSTEM

1.51 The pressure fuelling system is designed to permit fuelling at a rate of 200 gallons per minute (gpm) through a single point pressure fuelling receptacle, located at the trailing edge of the wing just inside the rear engine compartment access door. The system may be defuelled through the same receptacle at a rate of approximately 100 gpm.

Pressure Fuelling Switch Panel

1.52 The Pressure Fuelling Switch Panel is mounted in the aft engine access bay and is used by groundcrew during pressure refuelling operations. This panel has two switches: the CHECK SWITCH and the DROP TANK FUELLING switch. The CHECK SWITCH, labelled: **PRIMARY OFF, FUELLING ON, and SECONDARY OFF**, is used to test the operation of the dual float shutoff valves located in the fuselage and wing tank. The DROP TANK FUELLING switch, labelled **ON and OFF**, is used to energize the drop tanks solenoid pilot valves, permitting pressure fuelling of the drop tanks.

Pressure Fuelling

CAUTION

When external electrical power is not available during pressure fuelling of the aircraft, the functional tests of pressure fuelling shut off components cannot be performed. The wing and fuselage tank gravity filler caps must be removed during fuelling to prevent possible damage to the internal fuel tanks structure.

1.53 When the wing and fuselage tanks are being fuelled, fuel pressure opens the fuelling shutoff valve in each tank allowing fuel to enter the tank and, through sensing lines, the dual float pilot valves. When the tank is full, the floats close the pilot valve, causing pressure to increase in the sense lines which closes the shutoff valve. Each shutoff valve consists of a primary float and a secondary float, by moving the CHECK SWITCH to either the **PRIMARY OFF** or **SECONDARY OFF** position causes solenoids to raise the respective float to simulate the normal shutoff valve action at the maximum fuel capacity level. This check can be made only after the pressure fuelling operation has begun.

CAUTION

*Unless the DROP TANK FUELLING switch in the rear engine compartment is in the **OFF** position, fuel transfer from the drop tanks will not be possible in the air, except by extending the emergency generator.*

AL 8(0)

1.54 To fuel the drop tanks by means of the pressure fuelling system, electrical power is necessary. Placing the DROPTANK FUELLING switch on the Pressure Fuelling Switch Panel in the **ON** position energizes the normally closed solenoid pilot valve, permitting fuel pressure to open the drop tanks shut off valves and, subsequently, allowing flow to the drop tanks. Under these conditions, fuel also flows through the sensing lines to the drop tanks solenoid pilot valves. As each drop tank is filled, a float switch in the tank rises, breaking the electrical circuit to the energized solenoid pilot valve, causing the pilot valve to close. The pressure builds up in the sensing line which closes the shutoff valve stopping the flow of fuel to that tank.

1.55 When the Air Refuelling Store is installed instead of the centreline drop tank, the store is fuelled through its own pressure fuelling receptacle.

Pressure Defuelling

1.56 To defuel the integral wing tank, it is necessary to connect the defuelling hose to the pressure fuelling receptacle. To defuel the fuselage tank, it is necessary to operate the manual override check valve between wing and fuselage tanks. When the defuelling operation is begun, negative pressure in the pressure fuelling shutoff valves will open the valves and allow the fuel to be removed. When either the fuselage or wing tank becomes empty, the defuelling low level float valve opens, increasing the pressure behind the diaphragm of the shutoff valve, causing the valve to close. This prevents air from entering the defuelling line and breaking the siphon when one tank empties ahead of the other. To defuel the drop tanks through the pressure fuelling system, it is necessary to connect a source of air pressure to the capped tee in the drop tanks pressurizing system, and first transfer the drop tanks fuel into the integral wing tank.

AIR REFUELLING (TANKER) SYSTEM

1.57 The air refuelling system enables the aircraft to serve as a tanker for other aircraft. Fuel from the wing tank and the drop tanks may be transferred to the refuelling store. All fuel in the tanker aircraft except that contained in the fuselage tank may be transferred to the receiver aircraft.

Air Refuelling Store

1.58 The refuelling store carried on the centreline rack contains a 300 gallon fuel cell, a constant speed ram air turbine driven hydraulic pump, a hydraulically driven fuel pump, a hydraulically operated hose reel, and 50 feet of refuelling hose with a drogue. The store is capable of transferring fuel to the receiver aircraft at approximately 180 gpm. Provisions are made for dumping fuel overboard if necessary.

1.59 Fairings at the rear of the refuelling store contain two lights, amber (left side) and green (right side). The amber light illuminates when the hose is extended, indicating that the receiver aircraft may now engage the drogue, and extinguishes when the hose has been pushed forward far enough to allow fuel transfer. The green light illuminates when fuel is being transferred. The drogue basket is illuminated by four integral white lights powered by an air driven generator mounted in the drogue.

Air Refuelling Control Panel

1.60 The refuelling control panel (Figure 1-11), located in the forward cockpit on the left console, contains all the indicators and switches used to operate the system with the exception of the drop tank pressurization switch. The system is designed so that any sequence of switch positioning is possible without causing damage or malfunction to the store. The following paragraphs explain the various switch functions.

DROGUE POSITION Indicator

1.61 The DROGUE POSITION indicator has three possible indications:

- RET** – indicates when the drogue is fully retracted and during drogue extension.
- EXT** – indicates the drogue is fully extended and ready for receiver engagement.
- TRA** – indicates (during hose retraction) when the drogue has been engaged and approximately 4 feet of the hose pushed into the store allowing fuel to transfer. It also indicates during hose retraction.



Figure 1-11 Air Refuelling Control Panel

AL 8(0)

Gallons Delivered Counter

1.62 The GALSDEL counter registers the gallons of fuel transferred through the hose and drogue to the receiver in increments of 2 gallons. A reset knob is provided to reset counters to 0 when desired.

REFUEL Master Switch

1.63 The REFUEL master switch has three positions:

- a. **ON** – unlocks and unfeathers the air driven propeller at the forward end of the refuelling store.
- b. **OFF** – feathers and locks the propeller, provided the drogue is in the RET position.
- c. **DUMP** – a guarded selection that electrically opens a fuel dump valve in the bottom of the refuelling store.

Store DUMP Light

1.64 The store DUMP light will come on when fuel flows through the dump valve on the bottom of the store or when fuel flows from the store to the aircraft. When fuel flow ceases, either because of fuel depletion or because dump/transfer has been secured, the light will go off. A press to test feature for the bulb is incorporated.

Drogue Position Switch

1.65 The Drogue Position switch controls the hose and drogue positioning and is powered through the refuelling master switch. The drogue position switch has two positions:

- a. **EXT** – hose extends 50 ft to the trail position and the white light in the hose fairing is switched on to illuminate the hose. Extension of the drogue energizes a bypass relay. This relay prevents feathering of the air turbine regardless of the position of the refuelling master switch until the drogue is fully retracted.
- b. **RET** – hose retracts.

Fuel Transfer Switch

1.66 The fuel TRANS switch controls the flow of fuel after proper hookup is made. A holding relay is provided which causes the switch to remain in the **TRANS** position until store fuel is depleted or the pilot moves it to **OFF**.

Store LIGHT Switch

1.67 The LIGHT switch determines the brightness of the amber and green refuelling lights on the Air Refuelling Store. The switch has two positions:

- a. **BRT** – for daylight fuelling.

- b. **DIM** – for night. With the switch in **DIM**, store lights will not be visible in daylight.

SHIP TANK Switch

1.68 The SHIPTANK switch controls the transfer of fuel between the store and the aircraft and has three positions:

- a. **TO STORE** – pressurizes the wing to 6 psi causing fuel to flow from the wing tank to the refuelling store.

NOTE

With the SHIP TANK switch in the **TO STORE** position the EMERG TRANS caution light will be illuminated, and the wing fuel tank pressurization limits apply. Refer Chapter 4.

- b. **OFF** – No fuel transfer to or from the store.
- c. **FROM STORE** – the air refuelling store and drop tanks are pressurized with engine bleed air regulated to 10 psi transferring any external fuel to the wing tank.

NOTE

With the SHIP TANK switch in the **FROM STORE** position, all external drop tanks are pressurized (if fitted), regardless of the position of the DROPTANKS switch on the Engine Control Panel. The store DUMP light should illuminate.

Hose Jettison Switch

1.69 The HOSE JETT switch is provided to cut and crimp the store hose in the event of store malfunction which precludes drogue retraction. The switch also removes all electrical power from the store controls except for the dump facility on the refuelling master switch.

CAUTION

*Once the **HOSE JETT** position is selected, do not return the switch to its forward **OFF** position as the turbine will unfeather and cause the hose to be pulled from the guillotine crimper, spilling fuel in the store and creating a fire hazard.*

AL 8(6)

ELECTRICAL SYSTEM

POWER SUPPLY

Introduction

1.70 The A/TA-4 is equipped with a nominally rated 12.5 KVA generator with an electronically regulated frequency output.

1.71 This system provides AC power and, via two DC converters, 28 VDC power to the aircraft buses. Two additional transformers modify alternator power to 26 volt AC supply, for the operation of certain equipment. Eight buses serve to distribute power to the various electrical units. A pilot selected airstream operated emergency generator provides electrical power to essential equipment in the event of main alternator or engine failure. External power can be used to energize the system through an external power receptacle located in the lower forward left hand wing root. Operation of the electrical system is completely automatic, with the exception of the emergency generator, which must be activated by the pilot when required.

Variable Speed Constant Frequency Generator

1.72 A 12.5 KVA generator mounted on the front of the engine provides 115/200 VAC, 3 Phase, 400 Hz power over an input range of 2390 to 8560 rpm. The system electronically transforms the variable speed, mechanical power output into a constant frequency, controlled electrical power source with both under and over voltage, and frequency protection.

Emergency Generator

1.73 The emergency generator, rated at 1.7 KVA, is carried in a compartment in the lower right hand side of the forward fuselage. When the generator is released into the airstream, a variable pitch propeller governs the speed of the generator at approximately 12,000 rpm to provide 115/200 VAC 3 phase 400 Hz power to the primary and primary monitored buses.

Emergency Generator Release T-Handle

1.74 The Emergency Generator release T-handle is located on the far right side of the cockpit above the right console near the instrument panel, and provides control for release of the emergency generator into the airstream, in the event of main generator failure. As the emergency generator comes on line the main generator exciter field circuit is isolated, rendering the main generator inoperative. The primary and primary monitored buses are transferred to the emergency generator. If the horizontal stabiliser manual override lever is actuated while operating on the emergency generator, power to the primary monitored bus is lost. Upon releasing the manual override, power to the primary monitored bus is restored.

WARNING

Extreme caution should be exercised to avoid the Canopy Jettison Handle when deploying the Emergency generator. A palm down method of grasping the emergency generator handle is recommended. The emergency generator T-handle must be positively identified to preclude inadvertant selection of manual flight controls.

CAUTION

Sufficient emergency generator power to operate essential equipment is assured at a minimum of 145 KIAS gear down and 165 KIAS gear up. Prolonged trim motor actuation below these speeds may cause complete failure of the emergency generator by demagnetizing the permanent magnet rotor.

NOTE

High G manoeuvres, and touch and go landings with the emergency generator extended may overstress the emergency generator supports and are not recommended.

Once the emergency generator is extended, it can not be retracted to the normal stowed position, while in flight.

AL 8(5)

Emergency Generator Bypass Switch

1.75 The EMER GEN switch labelled **NORMAL/BYPASS** is located on the right hand console. If main generator power has been regained, the pilot can return to main generator operation by placing the emergency generator bypass switch in the **BYPASS** position. The front cockpit has a lift to lock the toggle switch while the rear cockpit has a solenoid actuated switch which is spring loaded to the **NORMAL** position. As long as main generator power is available, either cockpit can select **BYPASS** and cannot be overridden by the other cockpit. The rear cockpit switch is solenoid held in the **BYPASS** position and will automatically revert to the **NORMAL** position if main generator power is lost. The front cockpit switch must be manually moved from the **BYPASS** position.

CAUTION

If the aircraft has been operated on the Emergency Generator for a period of time, and operation on the normal generator is restored, the FPM may temporarily display inaccurate attitude information.

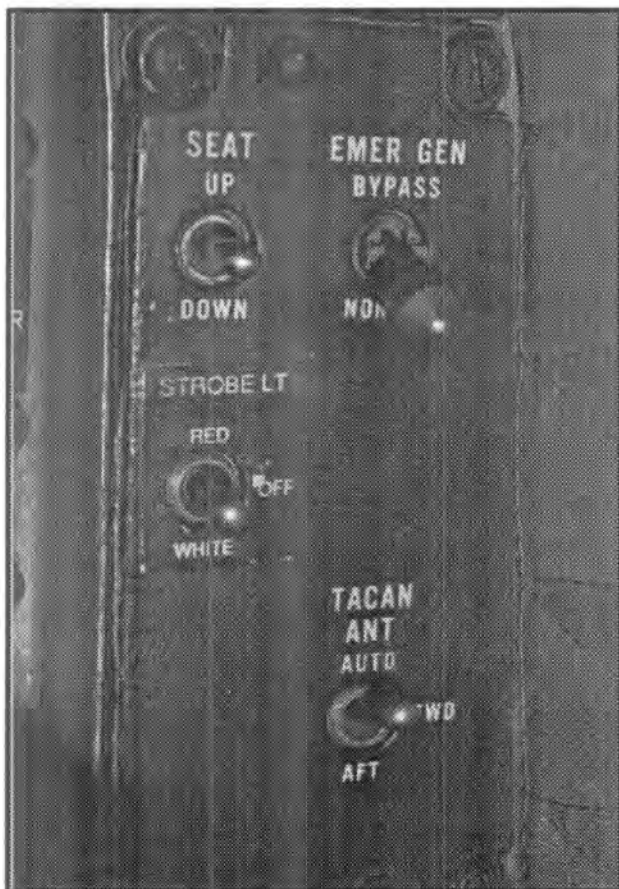


Figure 1-12 RH Wedge Panel

NOTE

If the emergency generator has been deployed with an operating main generator, main generator power will be regained during roll out as the emergency generator drops off line.

50 Amp DC Converter

1.76 This unit receives 3 phase AC power from the primary AC bus and delivers DC power to the primary DC bus. The voltage output ranges from 30.5 to 25 volts as the output current varies from 0 to 50 Amps.

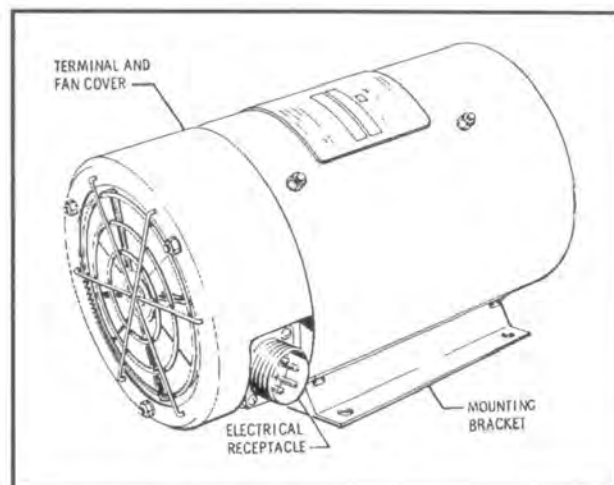


Figure 1-13 DC Converter

100 Amp DC Converter

1.77 This unit receives AC power from the aft monitored AC bus and delivers DC power to the aft and forward monitored DC buses. If the 50 Amp DC Converter (DC-1) fails, the 100 Amp DC Converter (DC-2) takes over and supplies DC power to the primary DC bus. When the RAT is deployed, and if the DC-1 converter fails, the DC-2 Converter supply is changed from the aft monitored AC bus to the primary AC bus. The DC-1 warning light is illuminated when the DC-1 converter fails. If the DC-2 converter also fails, the aft and forward monitored DC buses are disconnected and the DC-2 warning light is illuminated. Refer Foldout 5. The master caution light will not illuminate in this instance.

AL 8(5)

CONTROL AND DISTRIBUTION

AC Power Control Switch

1.78 The AC Power Control switch located in the leading edge of the left wing root disconnects the aft monitored bus from the main generator and connects it to the external power receptacle providing external power to the system.

Retraction Release Switch System

1.79 The retraction release switch system has two positions, **AIRBORNE** and **GROUND**. The position is sensed by the extension or compression of the left main gear strut during takeoff and landing. The switch affects the following services:

- a. While compressed (**GROUND** position), the undercarriage lever cannot be raised unless the serrated safety solenoid lever is held back. AFCS and STAB AUG cannot be engaged. Spoilers will open if armed, and the throttle is reduced below the 70% position. The following systems will be inoperative:

Indexer Lights	Transducer Heat
Radar	Elapsed Time (NAS)
Countermeasures	IFF Mode 4
Weapon Release	RWR Radar Altimeter Blanker

NOTE

Countermeasures and weapons release are also disabled by the gear handle in the **DOWN** position.

- b. When extended (**AIRBORNE** position), nose wheel steering is inoperative (will not engage). Indexer lights and transducer heat circuits are energized. Spoilers will not operate, and the park brake is inoperative.

Primary Bus

1.80 The primary buses supply power for essential flight services.

Monitored Bus

1.81 The monitored buses are isolated from the emergency AC supply under emergency power supply conditions.

Primary-Monitored Bus

1.82 The primary monitored bus is isolated from the emergency AC supply by the horizontal stabilizer override control, when it is used to trim the horizontal stabilizer under emergency power supply conditions.

Armament Bus

1.83 The Armament Bus receives DC power when the master armament switch is **ON** and the landing gear handle is **UP**. The armament bus is de-energized by an armament safety switch that is actuated when the landing gear handle is in the down position. This is a safety feature to prevent inadvertent firing of the guns or release of stores when the aircraft is on the ground or in the landing pattern with the wheels down.

Armament Safety Disable Switch

1.84 The Armament Safety Disable switch is located on the outboard side of the right hand wheel well for ground testing of the armament circuit. When the master armament switch is **ON** and the Armament Safety Disable switch is momentarily depressed, an armament safety disabling relay is closed, allowing power to energize the armament bus. The relay is held closed until the master armament switch is turned **OFF**, or electrical power is disconnected from the aircraft. When this occurs, the armament safety feature is automatically reinstated.

Fuse Panels

1.85 All electrical circuits are protected by fuses. Most fuses are located on panels: in the nosewheel well, and in the forward engine compartment.

LIGHTING

EXTERIOR LIGHTS

1.86 The exterior lights are controlled by seven switches on the Exterior Lighting Control Panel (fwd wedge panel) shown in Figure 1-14. In both the A-4 and TA-4 this panel is located outboard of the right console.

Navigation Lights

1.87 Wing tip, and tail lights include both filament and high intensity gas discharge types. The navigation lights are controlled by two three position switches marked **WING** and **TAIL**.

- a. **BRT** – directs power to the gas discharge lights.
- b. **OFF** – lights are off.
- c. **DIM** – directs power to the filament lights.

Fuselage Lights

1.88 A semi-flush white high intensity gas discharge and low intensity filament fuselage wing light are located under the leading edge of each wing. The fuselage lights are controlled by a three position switch marked **FUS** in a similar manner to the navigation lights.

1.89 A two position switch marked **FLSH** and **STDY** provides the capability to operate external lights in flashing or steady mode.

CAUTION

Application of external power or starting the aircraft with external lights selected to **BRIGHT** may cause failure of the lights. Allow 60 seconds for warm up after electrical power is applied to the aircraft.

Anti Collision Lights

1.90 The aircraft has two flashing red anti collision beacons. One is mounted on top of the fuselage and the other on the right main landing gear strut fairing. When the anti collision lights are selected, the white fuselage lights are turned off automatically.

High Intensity Strobe Lights

1.90a A dual high intensity strobe light is mounted on top of the fuselage forward of the anti-collision light. The strobe is controlled by a three position switch to the rear of the seat adjustment switch on the right console. The strobe may be selected from **OFF** to either **WHITE** or **RED**.

WARNING

The white high intensity strobe is potentially damaging to the human eye and should not be used in close proximity to ground personnel.

CAUTION

Use of the white high intensity strobe at night is not recommended due to the distracting nature of the emitted light. Use of the red high intensity strobe is not recommended for night formation flying.

NOTE

The strobe light switch is adjacent to the seat adjustment switch and may be inadvertently switched on whilst adjusting seat height.

Taxi Light

1.91 The taxi light is installed on the right hand main landing gear door. The light is controlled by the **TAXI** switch, and only comes on when the undercarriage is selected down.

Air Refuelling Probe Light

1.92 The air refuelling probe light is located on the right hand engine intake lip and is operated by a three position switch marked **BRT/OFF/DIM**.

Master External Light Switch

1.92a Overall control of the external lighting is via the Master External Lighting Switch, located on the left console, outboard of the throttle. The three position switch, labelled **EXT LIGHTS**, toggles between **OFF** and **ON**, and also has a spring loaded **FLASH** position.

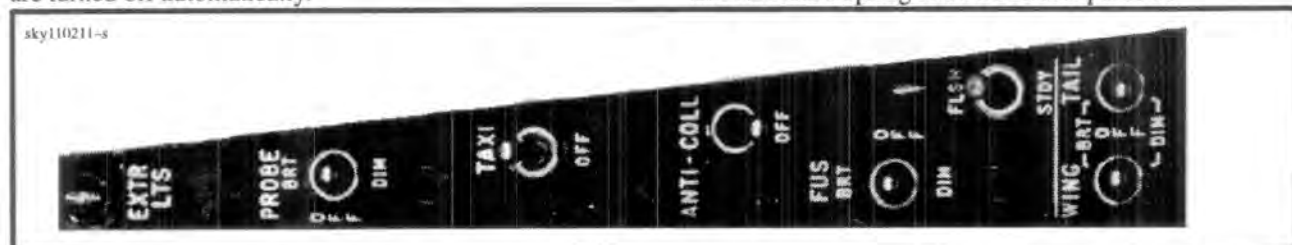


Figure 1-14 Ext Lighting Control Panel

AL 11(8)

INTERIOR LIGHTS

1.93 Except for the pilot kneeboard light, white floodlights, AOA indexer lights, and the FIRE warning light, all controls for the interior lights are on the interior lights panel on the right console. The FIRE light has no dimming facility.



Figure 1-15 Internal Light Panel

Primary Lighting

1.94 Integral and light panel lighting for primary flight instruments, NAS and armament panel select switches, transfer switches (TA-4), oil quantity indicator, and the warning lights are controlled by the **PRIMARY** knob which provides variable lighting from the **OFF** position.

Console Lighting

1.95 Integral and light panel lighting for the left and right consoles, and the wedge panels, are controlled by the **CONSOLE** knob which provides variable lighting from the **OFF** position.

Red Floodlighting

1.96 A toggle switch, marked **FLOOD**, with three positions, **BRT**, **DIM**, and **MED**, controls the intensity of the six red floodlights located in the cockpit to provide

auxiliary or emergency console lighting. The lights are not activated until the **CONSOLES** switch is rotated from the **OFF** position. The pilot's kneeboard light has a separate intensity control.

White Floodlighting

1.97 The four high intensity white floodlights, two for the instrument panel and one for each console, provide internal lighting. Floodlight intensity is controlled by a knob mounted on the fuselage skin above the right hand console.

Warning And Caution Lights

1.98 Twelve warning lights are arranged in a single column on the lower left of the instrument panel. All are orange except **LOW FUEL** and **WHEELS** which are red. Illumination of the lights and the condition indicated is described in Table 1-3.

Glareshield Warning Lights

1.99 In addition to the instrument panel caution light column, 5 caution lights are mounted beneath the lip of the glareshield in each cockpit (4 lights in the A-4) as shown in Figure 1-16. These lights illuminate as shown in Table 1-4.

1.100 The MASTER CAUTION light is operated by the Master Caution Controller Unit which monitors the following warning circuits:

LOW FUEL (Post-NZM/213.005/78 and 85)
FUEL BOOST
OIL PRESS
CONTROL HYD
UTILITY HYD
DC2

Table 1-3 Warning Light Indications

Light	Condition	Indication
LOW FUEL	Less than 1100 lbs of fuel remaining	Low Fuel Condition
FUEL TRANS	Wing tank fuel transfer pressure below 2 psi	Possible Fuel Transfer Pump failure; Unporting of transfer pump e.g. steep nose down condition or wing tank empty; Insufficient RPM to meet pump demand.
EMERG TRANS	Wing Fuel Switch selected to EMER TRANS	Switch Position Indicator
FUEL BOOST	Fuel Boost pressure below 4 psi	Fuel Booster pump inoperative
OIL PRESS	Engine Oil Pressure below 32 psi	Low Oil Pressure
CONTROL HYD; UTILITY HYD	Hydraulic system pressure below 650 psi or return pressure > 850 psi	Flight Control or Utility hydraulic system failure
WHEELS	Any Gear not DOWN with flap not UP and throttle below 92% RPM position	Gear UP warning
SPD BRK OPEN	Speedbrakes Open	Speedbrakes Open
SPOILER EXT	Spoilers up	Spoilers up
DC-1	50 Amp DC Converter inoperative	DC-1 Converter Failure
DC-2	100 Amp DC Converter inoperative	DC-2 Converter Failure

AL 12(6)

Table 1-4 Glareshield Warning Light Indications

LIGHT	CONDITION
CANOPY (TA-4 only)	Canopy Rifle Bolt not properly secured
RRS	Rain Removal System Selected ON
FIRE	Hot gases / fire detected
MASTER CAUTION	MCCU detects failure condition
BRAKE	Park Brake selected ON
IFF	When KIT-1C/TSEC transponder computer is fitted and Mode 4 is operational, <i>and</i> The aircraft is being interrogated but does not reply, <i>or</i> A fault in the KIT-1C/TSEC transponder computer exists, <i>or</i> The code in the KIT-1C/TSEC transponder computer has been zeroed

1.101 Once triggered by one of the above lights, the MASTER CAUTION remains lit until reset. To reset the MCCU and cancel the MASTER CAUTION light, momentarily move the COMM switch on the throttle to the **DOWN** position.

Fire Detection System

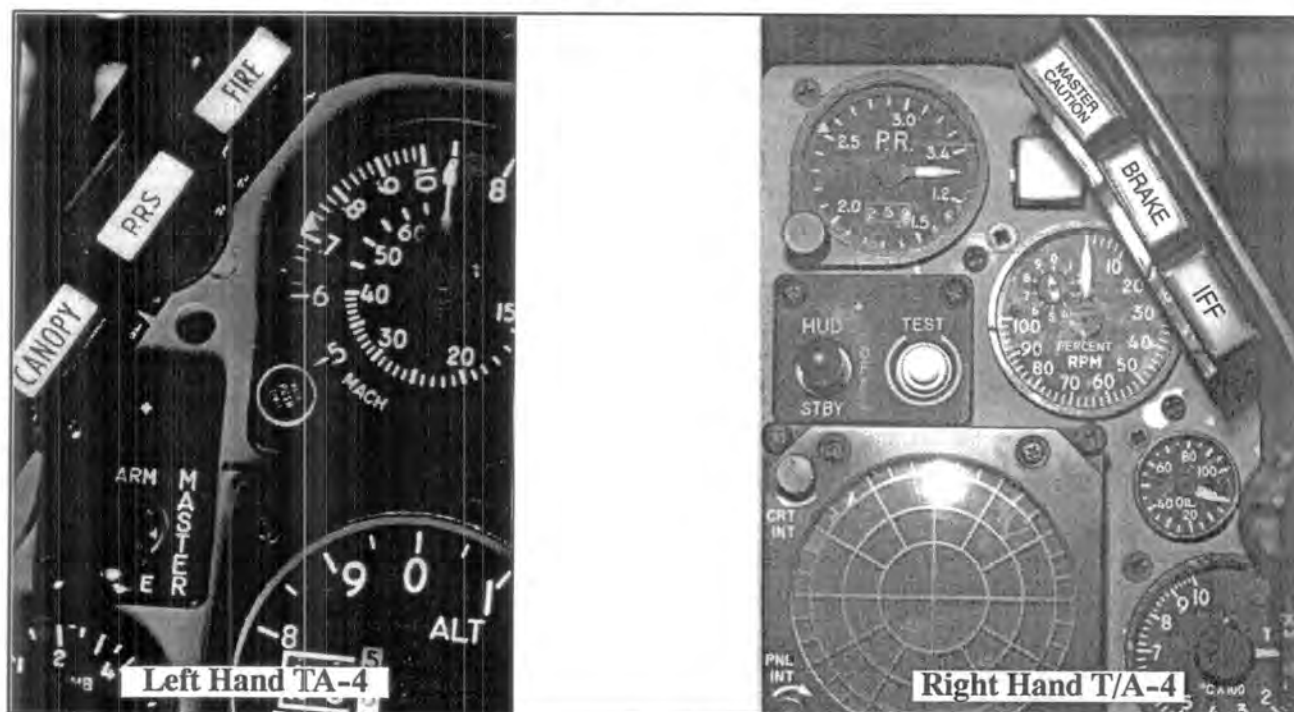
1.102 The fire detection system will indicate the existence of fire or hot combustible gases in the area surrounding the engine, tailpipe, and accessories section. If sufficient temperature is obtained in these locations, the FIRE warning light on the glareshield will illuminate. When the press to test button is depressed, the FIRE warning light will come on indicating a properly functioning circuit. This system discriminates against short circuits and prevents lighting of the fire warning light by either the fire detection control unit or press to test button when a short exists.

Master Test Switch

1.103 The instrument Master Press To Test button is used

to perform a lamp test on all status, caution and warning lights in the cockpit plus the fuel and oxygen indicating system. Pressing the Master Test button lights all lamps and causes the LOX and FUEL gauges to rotate anticlockwise.

The OIL LOW light must illuminate after a short delay of between $\frac{1}{2}$ and 3 seconds to confirm that the 20% sensing circuit is serviceable. The 80% sensing circuit is tested by releasing the Master Test button, pressing and holding the oil light button, then repressing the Master Test button. The OIL LOW light must illuminate after a short delay of between $\frac{1}{2}$ and 3 seconds. The LOW FUEL warning light should illuminate, indicating both lower and upper thermistors in the fuselage tank are serviceable. If LOW FUEL light fails to illuminate, or flickers, a fault condition exists. The LOW FUEL light may extinguish after a few seconds if the PTT button remains pressed. This is a function of the circuitry and is normal.

**Figure 1-16 Warning Lights Glareshield**

AL 8(0)

HYDRAULIC SYSTEM

INTRODUCTION

1.104 The hydraulic systems consist of the Utility Hydraulic System and the Flight Control Hydraulic System, utilizing two self pressurizing fluid reservoirs and two identical engine driven variable displacement pumps. Both reservoirs are located in the upper right hand side of the fuselage over the centre of the wing, with the flight control system reservoir aft of the utility system reservoir.

1.105 The utility control system is a self contained hydraulic system which supplies 3,000 psi constant pressure to the following sub-systems:

- Aileron, Elevator & Rudder Tandem Cylinders
- AFCS Aileron, Elevator and Rudder Servos
- Flaps
- Speedbrakes
- Spoilers
- Landing Gear
- Nose Wheel Steering
- Arrestor Hook (Retraction only)
- TA-4 Canopy

SYSTEM DESCRIPTION

Capacity

1.106 The hydraulic fluid capacity of the utility system reservoir is 1.25 US gallons and the flight control system 0.30 US gallons. Each system operates normally under a pressure of 3000 psi. Pressure relief valves in each system open at 3650 psi to prevent damage to the lines and equipment.

Operation

1.107 Tandem power cylinders are used in the aileron, elevator and rudder power packs; one half of each cylinder is operated by flight control system pressure, and the other

half by utility system pressure. This arrangement allows power operation of the ailerons, elevator, and rudder at reduced hinge moments by either system in the event of failure of the other system.

1.108 Hydraulic low pressure lights for each system are located on the warning light panel and are connected to the MASTER CAUTION system. Pressure gauges for both systems are installed in the right hand wheel well. No hydraulic pressure is available for ground operation unless the engine is running; however, there is a hand operated hydraulic pump, with a small reservoir, available for TA-4 canopy operation without engine power.

1.109 The engine driven hydraulic pumps for the flight control and utility systems are of the constant pressure, variable displacement type. The rate of fluid flow through each system will vary with the operating speed of the associated pump. Flow restrictors, used to regulate the maximum rate of flow, prevent the wing flaps, speedbrakes, and arrestor hook from operating too fast when fluid flow is at its peak, yet do not affect the time of operation when flow is reduced at low engine speeds. As long as the engine is turning at IDLE rpm or greater, the hydraulically operated units will operate against the usual loads.

1.110 At engine windmilling speeds, fluid flow is greatly reduced, and the time required for hydraulically operated units to respond fully is increased. Priority valves in the Utility System, set at 1450 psi, ensure that flight controls and spoilers, rather than services, receive hydraulic pressure at low engine speeds. Either the utility or flight control system can provide sufficient pressure for normal flight operations. Stiffening of the control stick may be noted at high speeds or during rapid control movements, when operating on the utility hydraulic system alone. Actuation of various units normally operated by utility pressure cause a temporary decrease in the effectiveness of the flight controls.

FLIGHT CONTROLS AND SURFACES

INTRODUCTION

1.111 The primary flight control systems are tandem full power hydraulic systems with artificial feel supplied by bungee springs in parallel with the controls. Motion of the stick or rudder pedals is transmitted through linkage and cable systems to the control valve. The valve ports fluid to the power cylinder, which actuates the control surfaces. Aileron and rudder trim is obtained by repositioning the neutral force point of a load feel bungee. Longitudinal trim is obtained by positioning the horizontal stabilizer. If total hydraulic power failure occurs, the aileron and elevator power cylinders may be disconnected to allow reversion to manual control. With loss of hydraulic power, the rudder control valve ports the two cylinder ports together so that the rudder can be controlled manually through the manual bypass linkage. Hydraulic servos, in parallel with the pilot operated controls, provide the control forces required for automatic flight control. The aileron and rudder control surfaces have rotary viscous dampers to reduce surface buzz.

CAUTION

Do not attempt manoeuvres requiring high control forces (such as high speed pullouts) when it is known beforehand that one or both control hydraulic systems are inoperative.

AILERONS

Aileron Control

1.112 Lateral movement of the control stick positions the aileron control valve so that hydraulic fluid at 3000 psi is ported to the aileron power cylinder. The aileron power pack operates push pull tubes to the ailerons. Because the hydraulic system is irreversible, there is no feedback to the pilot of airloads on the ailerons. Artificial feel is provided by a spring bungee.

Aileron Trim

1.113 An electrically powered aileron trim actuator is controlled by movement of the trim switch on the stick grip to LWD (left wing down) or RWD (right wing down). In the TA-4 if both pilots attempt to trim at the same time, opposing aileron trim signals will stop trim movement regardless of the direction or sequence of actuation. The

trim actuator moves the stick, power system linkages, and, consequently, the ailerons to the desired trim position by changing the neutral position of the aileron load feel bungee. At the same time, the actuator positions a follow up tab on the left aileron so that the aircraft remains approximately in trim whenever the power system is disconnected. If the hydraulic power system has been disconnected, continue to trim the ailerons in the same manner, the aileron trim tab will aerodynamically trim the surfaces. No indicator is provided to show the trim position of the ailerons and tab, but the control stick is displaced from centre to a new neutral position as the trim tab and ailerons are moved from their faired positions by the trim actuator.

NOTE

The position of the follow up tab has negligible effect on lateral trim during flight, utilizing either or both hydraulic power control systems.

The stick trim actuator is inoperative when operating on the emergency generator.

ELEVATOR

Elevator Control

1.114 Longitudinal movement of the control stick moves a pushrod attached to the elevator control valve, which ports hydraulic pressure to the elevator power control cylinder. The cylinder, through mechanical linkage, deflects the elevator surface as desired. Elevator power control system is aerodynamically irreversible, therefore, artificial feel is provided by a bungee spring. Front and rear bobweights, linked to the elevator controls, provide additional stick force under positive G loads to aid in prevention of inadvertent aircraft overstress. Under negative G loads, this design will react to nosedown pitch accelerations in a manner which reduces the stick force required. The longitudinal trim is provided by a movable horizontal stabilizer. The bungee spring is linked to the horizontal stabilizer so that the elevator deflects upward (stick moves rearward) while trimming noseup and deflects downward while trimming nosedown. The elevator moves approximately 8 degrees as the stabilizer travels from full throw up to full throw down. When hydraulic power is lost, the elevator stabilizer linkage is ineffective.

Horizontal Stabilizer Trim System

1.115 The entire surface of the horizontal stabilizer is moved by an electrically operated actuator to provide longitudinal trim. The actuator is controlled by forward and rearward movement of the trim switch to NOSEDOWN or NOSEUP. In the TA-4 the pilot first initiating horizontal stabilizer trim will control the direction of the horizontal stabilizer movement. Stabilizer travel is from twelve degrees noseup to one degree nosedown. The position of the horizontal stabilizer is shown on the trim position indicator. Refer Figure 1-17.

Manual Override Lever

1.116 A horizontal stabilizer manual override lever on the left console out board of the throttle will operate the horizontal stabilizer if the trim switch becomes inoperative or, if operating on emergency generator. The positions of the manual override lever correspond to those of the trim switch; and as the switch is spring loaded to the centre OFF position it must be moved to the full extent of its travel, in either direction, to operate the horizontal stabilizer.

CAUTION

Do not run the actuator against the stops during the preflight check. Use of the horizontal stabilizer manual override lever does not cut out the actuator motor when the horizontal stabilizer reaches full travel. Continued operation of the manual override lever in one direction, when the stabilizer is at the limit of travel, will burn out the actuator motor and cause complete loss of stabilizer control. In addition, this may result in structural damage to the horizontal stabilizer actuator and mounting structure.

Hydraulic Power Disconnect

1.117 A manual flight control T-handle on the lower right side of the instrument panel, may be used to disconnect the elevator and aileron power cylinders from the flight controls in the event of complete hydraulic systems failure. After disconnect, stick forces are high, particularly for lateral deflections. At airspeeds in excess of 300 KIAS, stick forces become extremely high.

WARNING

Positively identify the manual flight control T-handle before operating it to preclude inadvertent jettisoning of external stores.

CAUTION

Hold the T-handle while allowing it to return to the stowed position. This procedure is to prevent handle striking an instrument.

NOTE

There is no hydraulic disconnect for the rudder.

As long as (normal) electrical power is available, the aircraft can be trimmed. Trim the aircraft immediately if it should roll when the manual flight control handle is pulled, during an actual hydraulic system failure.

Prior to performing a hydraulic power disconnect under controlled conditions, the emergency generator should first be extended and a functional check of the emergency trim override should be made. If the emergency trim functions properly on emergency generator, switch to BYPASS and continue with disconnect.

If normal electrical power and utility hydraulic pressure is available after disconnect, the AFCS may be used to reduce stick forces.

RUDDER

Rudder Control

1.118 The aircraft is equipped with a rudder system operating at a reduced hydraulic pressure of 1150 psi. The rudder power control is operated by the flight control system and the utility system at this reduced pressure. Movement of the rudder pedals mechanically positions the rudder electromechanical dual input servo valve. The valve ports hydraulic pressure to the rudder actuating cylinder as required. Since there is no feedback of airloads on the control surface of a hydraulic power system, a spring bungee is installed in the fin to centre and restrain the control valve and rudder pedals, and to provide artificial feel. The rudder pedals are independently adjusted for position by a lever located on the inboard side of each pedal.

Rudder Trim

1.119 Directional trimming is accomplished by displacing the entire rudder surface as a result of repositioning the neutral point of the spring bungee through the action of an electrical motor controlled by the rudder trim switch on the left hand console. If both pilots attempt to trim at the same time, opposing rudder trim signals will stop the trim movement regardless of the direction or sequence of actuation. Positions of the trim control are **NOSE LEFT** and **NOSE RIGHT**. Rudder trim position is shown on the trim position indicator. Trim is not available during emergency generator operation.

NOTE

Loss of rudder hydraulic power results in loss of rudder trim.

Trim Position Indicators

1.120 The positions of the rudder trim and the horizontal stabilizer are shown on the trim position indicators on the right hand console. The rudder trim position indicator is graduated in one degree units. Total travel of the rudder trim position indicator travel represents 7 degrees of rudder left and right of centre. The scale for horizontal stabilizer position is graduated in one degree units anti-clockwise from **DN** (down) to **UP**.

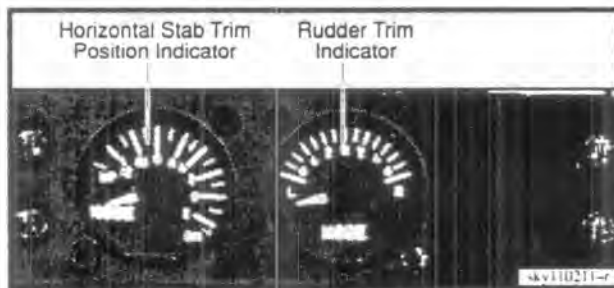


Figure 1-17 Trim Indicators

WING FLAPS

1.121 Split flaps are installed on the trailing edge of the wing. The flaps are hydraulically actuated by a single cylinder and are mechanically controlled by the wing flap handle located on the left console outboard of the throttle. The wing flap lever has 3 positions, these are:

- UP** – Flaps retract fully.
- STOP** – Stops the flaps at any intermediate setting.
- DOWN** – Allows the flaps to extend to a maximum of 50 degrees.

1.122 The position of the flaps is shown on the flaps position indicator. Each unit corresponds to one quarter of the total amount of extension possible. Labelled positions are **UP**, $\frac{1}{2}$, and **DOWN**. A relief valve in the wing flap system allows the flaps to blow back when the airloads cause the hydraulic pressure within the actuating cylinder to exceed 3650 psi. This automatic retraction will begin at approximately 230 KIAS.

NOTE

The flaps will not return automatically to the extended position after blow back, if the flap handle is in the **STOP** position.

WING SPOILERS

1.123 The spoilers are hydraulically actuated and electrically controlled by the spoiler **ARM-OFF** switch located on the left console outboard of the throttle. Utility hydraulic pressure will extend the spoilers only when the following conditions exist:

- The **ARM-OFF** switch is positioned to **ARM** in either cockpit.
- The left main landing gear strut is compressed.
- The throttle position is below 70% RPM.

WARNING

*After takeoff ensure the spoiler arm switch is **OFF**. An under-inflated left strut compressed in the wheel well or a malfunctioning retraction release safety solenoid can cause an inflight actuation of the spoilers when other actuation conditions are met. The spoilers should not be armed if the AOA Indexer fails to light after lowering the landing gear. In this situation Arm the spoilers only after the aircraft is firmly on the runway. If armed spoilers are required, throttle position must be maintained above 70% engine RPM to preclude inadvertent spoiler actuation.*

1.124 The spoilers will immediately dump to a faired position during a touch and go when the throttle is advanced above the 70% engine RPM position. The spoilers are inoperative on the emergency generator.

NOTE

When spoilers are actuated with the engine in the idle rpm range, the decrease in hydraulic pressure may cause the utility system ladder light to flash momentarily, and the MASTER CAUTION light to illuminate

SPEEDBRAKES

1.125 Two flush mounted speedbrakes, one on each side of the fuselage, provide deceleration during flight. The speedbrakes are hydraulically operated and electrically controlled from either cockpit by a three position speedbrake switch located on the inboard side of the throttle grip. The switch is spring loaded to the hold position. Momentary operation of the switch in either cockpit to the OPEN or CLOSE position will cause the speedbrakes to open or close completely, therefore intermediate positions cannot be selected. In the TA-4, the pilot selecting speedbrakes open will control the speedbrake operation in the event of simultaneous operation of the speedbrake system.

1.126 The SPD BRK OPEN warning light, located on the warning light panel illuminates whenever the speedbrakes are in any position other than fully closed. A relief valve allows the speed brakes to blow back when the airloads against them cause the hydraulic pressure in the actuating cylinders to exceed 3650 psi, preventing damage to the speedbrake system. The speedbrakes begin to blow back at approximately 490 knots and will not open fully above 440 KIAS.

Speedbrake Elevator Interconnect

1.127 The speedbrakes are interconnected with the operation of the elevator to assist the pilot in overcoming

trim changes resulting from speedbrake operation. A system of cables and springs attached to the left speedbrake actuates the elevator control cables. When speedbrakes are opened, this system pulls the nosedown elevator cable, moving the stick forward and actuating the elevator to reduce noseup pitch. When the speedbrakes are closed, the stick moves back to its original trimmed position, thus reducing nosedown pitch.

Emergency Speedbrake Control

1.128 The aircraft is equipped with an emergency speed brake solenoid valve override control. The emergency speedbrake control is a push pull knob located at the rear of the left console in the front cockpit only. The emergency speedbrake control will open or close the speedbrakes in the event of an electrical failure or failure of one of the speedbrake control valve solenoids. The emergency speedbrake control knob is held in a neutral position by the action of a spring bungee and must be pulled up or pushed down to open or close the speedbrakes.

WING SLATS

1.129 Aerodynamically controlled slats are installed on the leading edges of the wings to improve airflow characteristics over the wing surfaces at high angles of attack, primarily during approach and landing. The wing slats will open and close independently and automatically as the aerodynamic loading on them dictates. Because so many variables – airspeed, gross weight, and applied load factor – affect the operation of the wing slats, no fixed airspeed can be established as the point at which the slats begin to open or close. In general, however, they begin to open at some airspeed below 200 knots, and are fully opened at the stall. Slats should be 1/2 open when on approach at optimum angle of attack.

VORTEX GENERATORS

1.130 To help reduce buffet and random wing drop at high altitude and high angle of attack, vortex generators are installed along the span of the slats and on the upper surface of the wing forward of the ailerons.

LANDING AND ARRESTING SYSTEMS

LANDING GEAR

1.131 The tricycle landing gear is retracted and extended by utility hydraulic system pressure during normal operation. The main gear retracts up and forward and the wheels rotate to fit flush into the wheel wells in the wings. The nose gear also retracts up and forward. The nose strut telescopes to allow the nosewheel to fit into the nosewheel well. When retracted, the landing gear is held up by utility hydraulic pressure.

Landing Gear Handle

1.132 A landing gear control handle located forward of the left cockpit rail controls normal operation of the landing gear system. The landing gear control handle has two positions, **UP** and **DOWN**, and is mechanically linked to the landing gear control valve.

1.133 A mechanical latch lever guard on the gear handle together with a solenoid operated downlock release latch immediately behind the gear handle (TA-4 front cockpit only) prevent inadvertent movement of the handle. The release latch operates via the retraction release switch on the left main gear, or manually (in the event of solenoid failure) by moving the serrated release latch rearward.

1.134 In the A-4, the downlock release latch locks the gear handle in the **DOWN** position. The latch is retracted whenever weight is off the wheels enabling the gear handle to be selected **UP**. The lever guard then locks the handle in the **UP** position and must be depressed in order to select gear **DOWN**.

1.135 In the TA-4, the release latch locks the forward cockpit gear handle in both the **UP** and **DOWN** positions. The release latch is retracted whenever weight is off the wheels *and* the lever guard is depressed, hence the lever guard must be depressed in order to select gear **UP** or **DOWN**.

TA-4 AIRCRAFT ONLY

CAUTION

If the downlock release latch is not seated with the landing gear up and locked, inadvertent landing gear extension is possible during accelerated manoeuvres.

NOTE

If the landing gear handle cannot be raised and the angle of attack (AOA) indexer does not come on immediately after takeoff, a possible retraction release switch malfunction is indicated.

If electric power to the safety downlock solenoid fails, the downlock release latch can be manually moved rearward. The landing gear control handle can then be moved **UP** or **DOWN** to accomplish ground maintenance or airborne emergency gear up or gear down actuation.

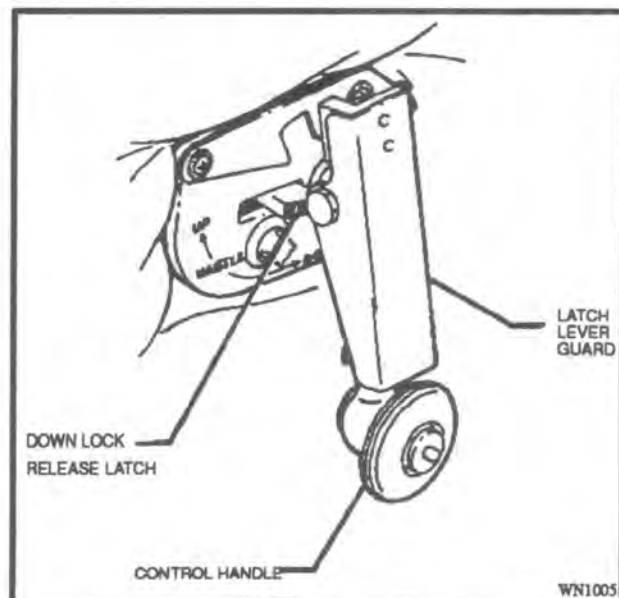


Figure 1-18 Landing Gear Control Handle and Linkage

A-4: held down by latch lever guard locking up
 TA-4: latch holds up & down when up & down must still push lever guard to get latch off to gear down

Emergency Landing Gear System

1.136 In the event of utility hydraulic system failure, the landing gear rests on the landing gear doors which are held closed by mechanical latches. For the landing gear to be lowered manually the door latches are mechanically released by pulling the emergency landing gear release handle, located on the left side of the cockpit above the left console. The landing gear extends and locks by a combination of gravity and ram air force.

CAUTION

Damage may be sustained by the bulkhead brackets and the landing gear handle ratchet if the landing gear handle is raised after the emergency landing gear release T-handle is pulled.

Undercarriage Indicators

1.137 The position of the landing gear is shown by magnetic indicators on the Undercarriage Indicator Panel, located on the front left console.

1.138 In addition, a warning light in the wheel shaped landing gear control handles will light whenever the handle position does not match the position of the landing gear, and will remain on until all the wheels are locked in the appropriate position. A flashing type wheels warning light, located on the caution panel, warns the pilot of a possible unsafe condition, whenever power is <92%, the flaps are not up and the undercarriage is not locked down.

Light on when all gear not down & locked
Same for wheels light. Need all 3 locked

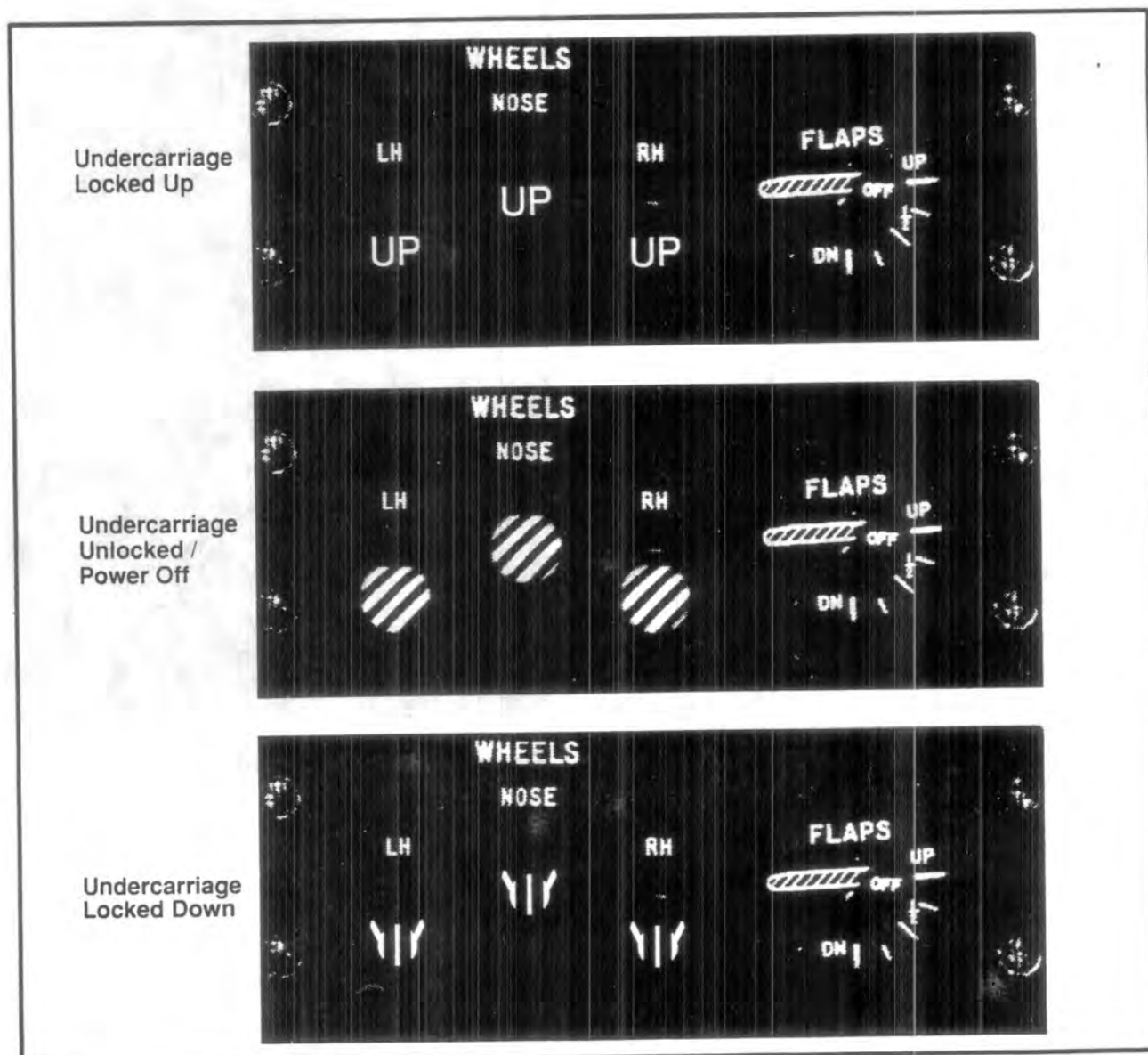


Figure 1-19 Undercarriage Indicator Panel

NOSEWHEEL STEERING

Operation

1.139 The nosewheel steering system is hydraulically operated and electrically controlled by the AP switch on the control column and from inputs from the rudder pedals. Steering may be engaged provided all the following conditions exist:

1. The NORM-EMER OFF steering switch(es) is in the **NORMAL** position.
2. Utility hydraulic pressure and normal electrical power exists.
3. Weight is on the main landing gear (retraction release switch on the left main landing gear).

1.140 The nosewheel position is a function of rudder displacement. The degree of displacement is electrically transmitted to a servo on the nosewheel steering actuator, driving the nosewheel to a maximum of 45 degrees either side of centre. Once the nosewheel is driven beyond 45 degrees of centre, it castors freely and must be brought within 45 degrees of centre using differential braking before electrical and hydraulic control can be regained. Any amount of left or right rudder trim will proportionally limit the nosewheel travel in the direction of rudder trim. This occurs as a result of repositioning the neutral point of the rudder bungee, which mechanically limits the amount of nosewheel steering available.

CAUTION

Activation of the nosewheel steering system is not recommended during landing/take off roll unless normal rudder/brake control is not effective. Less rudder is required to counteract crosswind or drift with nosewheel steering engaged. If nosewheel steering is engaged while the rudder is deflected to counteract crosswind or drift, the rudder pedal pressure must be decreased simultaneously. If the same amount of rudder deflection is maintained after

nosewheel steering is engaged, swerving and/or possible loss of directional control may result.

Nosewheel Steering Switch

1.141 This switch, located outboard of the throttle, enables the Nosewheel Steering system to be disabled electrically by placing the Nose Wheel Steering (NWS) switch in the **EMER OFF** position. The switch is shown in Figure 1-20.

WARNING

*In the **EMER OFF** position the switch eliminates the ability to compensate for a hydraulically induced nosewheel displacement.*

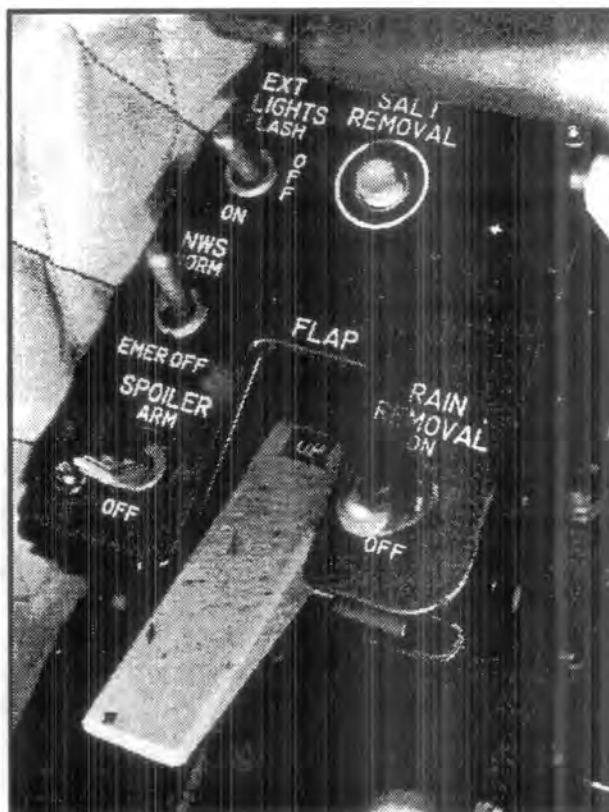


Figure 1-20 Spoiler and NWS Switches

BRAKING

Wheelbrakes

1.142 Dual disc, spot type brakes are installed on the main landing gear. The brake system includes a separate hydraulic reservoir located within the contoured area of the canopy behind the rear cockpit (TA-4), and in the nose section (A-4). Toe pressure on the upper half of the rudder pedals actuates the master brake cylinders to provide the necessary hydraulic pressure for braking action.

CAUTION

Braking is not recommended on wet or greasy surfaces until aircraft speed has reduced to below 80 KIAS to reduce the risk of a blown tyre and subsequent loss of directional control.

NOTE

The wheelbrakes are a completely independent hydraulic system. The pilot should realize that he will have brakes even though he lands with complete hydraulic system failure.

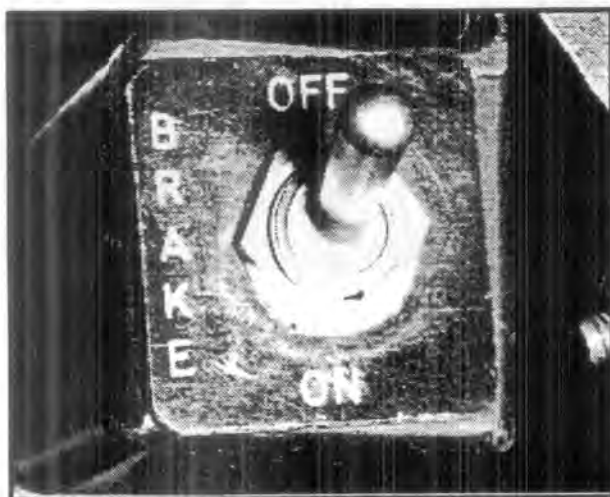


Figure 1-21 Park Brake Switch

Park Brake

1.143 A park brake facility, powered from the ground position of the Retraction Release switch, is selected by a two position switch, located on the right hand side of the glare shield. On the TA-4 the park brake facility is only available in the front cockpit. The park brake is operated by depressing the brake pedals fully and moving the brake switch to ON. This activates two solenoid valves preventing reverse flow from the brake unit pressure lines. A caution light on the glareshield marked BRAKES,

illuminates when the brake switch is in the ON position. The brakes will remain on until either the brake switch is returned to the OFF position, or electrical power is removed from the aircraft.

ARRESTOR HOOK

Operation

1.144 An externally mounted arrestor hook is installed on the lower rear fuselage. Retraction and extension of the hook is accomplished by a pneumatic hydraulic hold down cylinder in the rear engine compartment. The hold down unit is essentially a reservoir which is divided into two chambers by a relief valve and orifice arrangement. The upper chamber is filled with hydraulic fluid to the full level and then charged with compressed nitrogen to 900 ± 50 psi with the hook retracted. The lower chamber contains the actuating piston which is attached to the arrestor hook. Utility hydraulic system pressure is applied to the lower side of the piston to effect retraction of the arrestor hook, which is then held in the retracted position by a mechanical latch. Compressed air pressure and the weight of the arrestor hook cause extension when the latch is released. With the arrestor hook extended, the system provides snubbing action to keep the hook on the deck during an arrested landing.

Arrestor Hook Control

1.145 An arrestor hook handle on the right cockpit rail controls the operation of the arrestor hook. When the handle is moved to DOWN, the arrestor hook is manually unlatched, allowing nitrogen pressure from the hold down unit and gravity to extend the hook.

CAUTION

The arrestor hook handle should be firmly placed into position, not flipped nor slammed.

1.146 A light in the hook handle will illuminate when the hook is in transit and extinguishes when the hook is fully up or down. The UP position of the handle manually positions the arrestor hook control valve so that utility hydraulic fluid at 3000 psi flows into the lower part of the arrestor hook hold down cylinder overriding the air pressure, causing the hook to be retracted and latched against the lower surface of the fuselage. The arrestor hook system employs a fail safe feature which allows the hook to be extended in the event of cable system failure or hydraulic pressure failure. However, the pilot can not retract the arrestor hook without hydraulic pressure.

Down by N²
Up by util hyd. N² as goes up
Locked up mechanically

DRAG CHUTE

1.147 A drag chute is installed to provide rapid deceleration during the initial part of a landing roll or for emergency use during an aborted takeoff. The drag CHUTE switch is located under the left side of the glareshield. The drag chute, canister, and release mechanism are located below the tail pipe. The CHUTE switch is a two position, lever lock switch that has the following markings:

- a. **STOW** – In this position the chute is stowed.
- b. **DEPLOY** – On selection an electrical actuator releases the spring loaded canister cap allowing the drag chute canopy to deploy.
- c. **JETTISON** – After chute deployment returning the switch to **STOW JETTISON** position opens the riser hook to allow the drag chute to be jettisoned.

CAUTION

Do not deploy the drag chute at speeds above 175 KIAS.

The drag chute risers and stowage bag will be damaged if high rpm is used with drag chute deployed. If high rpm is required to clear the runway, the drag chute should be jettisoned on the runway.

BARRICADE ENGAGEMENT DETENTS

1.148 Three barricade engagement detents are installed along each leading edge to ensure proper barricade

engagement. Two of the detents are spaced evenly on each wing slat, the third is on the leading edge of the wing, inboard of the slat.

WARNING

Most of the barricades in use in South East Asia and Australasia are unsuitable for use with the A-4 due to the possibility of cockpit damage and thus injury from the top wire. A long field arrest is the only recommended method for preventing an overrun of the runway available.



Figure 1-22 Drag Chute Switch

FLIGHT INSTRUMENTS

HEAD UP DISPLAY

1.149 The primary flight instrument is the HUD. All navigation, attitude, and weapon aiming information is displayed on the HUD superimposed against the outside world, thereby enabling the pilot to devote his attention outside the cockpit. The HUD contains an Up Front Controller which enables the pilot to interface directly with the NAS. For detailed information on HUD operation and symbology refer to Chapter 7.

DISPLAY UNITS

1.150 In addition to the HUD, two Display Units provide AGM-65 video, radar video, cockpit camera video and alphanumeric text. DU operation and symbology are detailed in Chapter 7.

HEADS DOWN FLIGHT INSTRUMENTS

1.151 Several heads down flight instruments are also provided, as a backup to the HUD. These are the combined speed indicator, vertical velocity indicator and altimeter which are connected to the pitot-static system, and an Attitude Director Indicator and Horizontal Situation Indicator which are electrically operated.

1.152 An angle-of-attack system and radar altimeter provide information directly to the HUD. There are no head down gauges. The accelerometer has been removed as normal load factor is derived from the INU and displayed directly on the HUD.

Combined Speed Indicator

1.153 A combination airspeed indicator and Mach meter is mounted on the upper left corner of the instrument panels in the forward and aft cockpits. The airspeed portion of the dial is fixed in position and is calibrated from 80 to 650 knots. The Mach meter scale is a rotating disc, marked from 0.50 to 2.9, turning beneath the airspeed dial. Only a portion of the disc can be seen through a cut-out in the airspeed dial. Airspeed and corresponding Mach number are indicated simultaneously by a single needle pointer. A movable index on the Mach number disc is used to set a Mach reference by depressing and turning a set knob on the lower left corner of the instrument case. On the edge of the airspeed dial is an airspeed index pointer, which is adjustable through a range of 80 to 145 knots merely by turning the set knob.

Vertical Velocity Indicator

1.154 A vertical velocity indicator is located in the upper left-hand corner of each instrument panel. The indicator

shows the rate of ascent or descent of the aircraft. The upper half of the indicator face is graduated in 500-foot units from 0 to 6000 feet with 100-foot scale divisions from 0 to 1000 feet. The upper half of the instrument indicates rate of climb in thousands of feet per minute. The lower half of the indicator face is identical to the upper half except that it indicates rate of descent. The vertical velocity indicator is connected to the static pressure system of the aircraft and measures the change in atmospheric pressure as the aircraft climbs or descends.

Altimeter

1.155 The AAU-32/A Encoding / Barometric Altimeter is a self contained unit which consists of a precision pressure altimeter combined with an altitude encoder. It is calibrated from -1000 feet to +50,000 feet. Altitude is displayed in digital form by a 10,000 foot counter, a 1000 foot counter, and a 100 foot drum. A single pointer also indicates hundreds of feet on a circular scale with centre graduations of 50 feet. Below 10,000 feet, a diagonal warning symbol appears on the 10,000 foot counter. A barometric pressure setting knob is provided to insert the desired altimeter setting in millibars. With the correct QNH set in the millibar subscale the altimeter should agree to ± 75 feet of the field elevation.

1.156 A DC-2 powered vibrator operates inside the altimeter whenever power is on. If the internal vibrators become inoperative due to internal failure or DC-2 power failure, the pointer and drum may momentarily hang up when passing from "9" through "0" (climbing) or from "0" through to "9" (descending). This hang up will cause lag, the magnitude of which will depend on the vertical velocity of the aircraft and the friction in the altimeter.

CAUTION

If the barometric pressure setting knob binds or sticks, abnormal force should not be used to make the setting as this may cause internal gear failure resulting in altitude errors. Settings can sometimes be made by backing off and turning at a slower rate.

NOTE

If the internal vibrator is inoperative be watchful when the minimum approach altitude lies within the "8" to "1" part of the scale, i.e. 800-1100 feet, 1800-2100 feet etc.

1.157 If AC power to the altitude encoder is lost, a warning flag placard "Code Off" will appear in the upper left portion of the instrument face, indicating that the altitude encoder is inoperative and that the system is not reporting altitude to ground stations.

CAUTION

A minimum of one minute warm up time is essential prior to setting or checking the altimeter.

NOTE

The "Code Off" flag monitors only the encode function of the altimeter. It does not indicate transponder condition. The AIMS altitude reporting function may be inoperative without the "Code Off" flag showing, in the case of a transponder failure or an improper control setting.

It is possible to get a good Mode C test on the transponder control with the "Code Off" flag showing. Display of the "Code Off" flag only indicates an encoder power failure or a "Code Off" flag failure. In this event check that AC power is available.

TA-4 AIRCRAFT ONLY

1.158 The AAU-31A barometric altimeter is similar in presentation to the front cockpit AAU-32A altimeter but without the "Code Off" flag and encoding facility. It is fitted in the aft cockpit.

Attitude Director Indicator

The Attitude Director Indicator (ADI) provides the pilot with aircraft pitch and roll attitude information. Included on the ADI are needle pointers which provide steering indications for navigation and weapon delivery (refer Figure 1-23). The pitch and roll information is derived internally by the ADI. This attitude data is used by the NAS as backup attitude information.

Bank Angle Index

1.159 The bank angle index is fixed to the roll axis of the vertical gyroscope. It is stabilized to earth-gravity vertical by the vertical gyroscope. When referenced to the bank angle scale, it indicates the aircraft roll attitude relative to the earth's surface.

Bank Angle Scale

1.160 The bank angle scale is fixed to the instrument case. It rotates with the aircraft to indicate angular displacement in roll relative to the bank angle index during manoeuvres.

Spheroid

1.161 The spheroid represents the earth. It is mechanically coupled to the vertical gyroscope to provide indication of aircraft attitude in roll and pitch relative to the earth's surface. The spheroid is marked in 5-degree increments in pitch. The black area of the spheroid indicates dive. The gray area of the spheroid indicates climb. The horizon line is white.

Power OFF Flag

1.162 A power **OFF** flag is incorporated within the ADI display. The flag retracts from view immediately upon application of power. The flag comes into view whenever one of the following conditions occurs:

1. Loss of input power (including loss of just one phase)
2. Improper retraction of the caging lever

1.163 When power is lost, a minimum of 3 minutes of roll and pitch attitude indications will remain.

Miniature Aircraft

1.164 The miniature aircraft symbol represents the aircraft nose and wings. It indicates the aircraft roll and pitch attitude relative to the spheroid horizon line. The position of the miniature aircraft is adjustable vertically by means of the cage/pitch trim knob to compensate for varying aircraft pitch attitudes.

Cage/Pitch Trim Knob

1.165 The CAGE/PITCH TRIM (PULL TO CAGE) knob is a dual-function control. When pulled **OUT**, the internal vertical gyroscope cages, or aligns to the instrument case in roll and pitch. When **IN** and rotated, the position of the miniature aircraft adjusts vertically to compensate for varying aircraft pitch attitudes. This knob is spring loaded to return to the **IN** position; however, pulling out and rotating clockwise locks it in the **OUT** position.

Slip/Skid Indicator

1.166 The SLIP/SKID indicator is an inclinometer that detects the presence of slip or skid during an aircraft turn, and allows for accurate lateral trim adjustments.

Rate of Turn Pointer

1.167 The ADI displays the aircraft rate of turn as determined by an independent rate gyro. A deflection of one pointer width represents a 90 degree per minute rate of turn. A deflection of two pointer widths represents a 180-degree per minute rate of turn, i.e., Rate 1.

AL 8(5)

Pointer Test Switch

1.168 The pointer TEST switch applies a signal to the rate of turn pointer, causing it to deflect two pointer widths to the right. Releasing the switch returns the pointer to the centre position.

Horizontal Pointer

1.169 This pointer is stowed out of view at all times except when the VOR receiver is receiving ILS information and NAVAID REFERENCE is selected on the NAV panel. Under these conditions the horizontal pointer represents the ILS glideslope displacement from the aircraft.

Vertical Pointer

1.170 The vertical pointer provides lateral steering commands in both the weapon delivery and navigation modes. When FIXED COURSE is selected on the NAV panel, the steering command is based on the aircraft deviation from the desired course selected on the HSI. When DIRECT COURSE is selected, the steering command is based on the difference between aircraft track angle and bearing to destination. When PLANNED COURSE is selected, the steering command is based on the aircraft deviation from the computed ground track between the last and currently selected destinations.

1.171 When the VOR receiver is receiving ILS information and NAVAID REFERENCE is selected on the NAV panel, the vertical pointer represents the ILS localizer displacement from the aircraft.

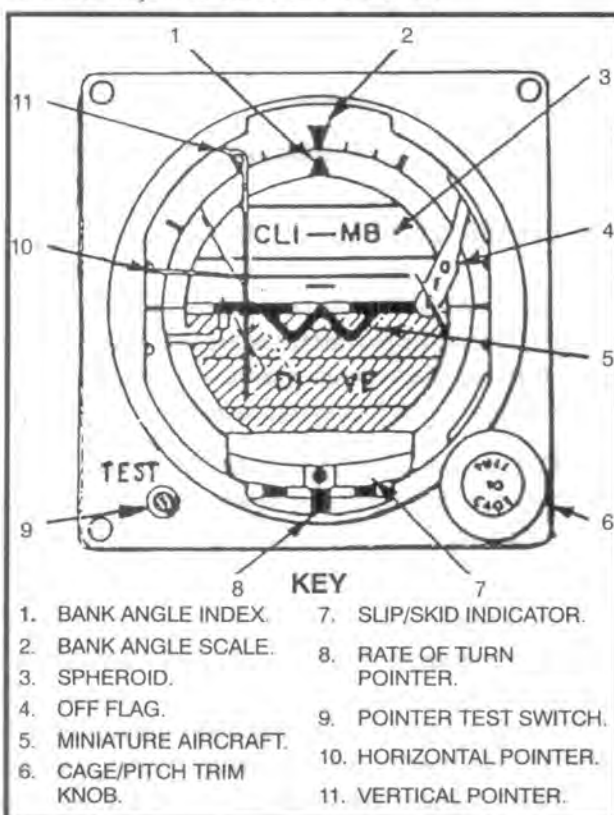


Figure 1-23 ADI Indicators and Controls

CAUTION

The ADI glideslope presentation includes parallax error. From a normal seat position, this will put the pilot below glideslope.

Horizontal Situation Indicator

1.172 The Horizontal Situation Indicator (HSI) provides displacement and horizontal position indications relative to a steer-to destination, TACAN station, VOR/ILS station, or UHF NDB station. The HSI indicators and controls are shown in Figure 1-24.

Bearing Pointer

1.173 The bearing pointer normally indicates the bearing to the selected steer-to destination or NAVAID with respect to the nose of the aircraft. If magnetic heading is invalid then the tail of the needle will indicate the radial which the aircraft is on (provided NAVAID is selected on the NAV panel). When ADF is selected on the ARC-159 control panel, the bearing pointer indicates the relative bearing to the tuned radio station. The ADF function has priority over all other functions of the bearing pointer.

Lubber Line

1.174 The lubber line is a reference index to which all course or heading information is related. This line is an extension of the nose of the fixed aircraft symbol and can be thought of as the direction of the nose of the aircraft. This line is fixed within the HSI case.

Heading Marker

1.175 The heading marker is manually rotated by the heading set knob.

Course Display

1.176 The course display is a three-digit numeric display that indicates the selected course. It provides the same information as the course pointer.

Power OFF Flag

1.177 The power OFF flag indicates the presence or absence of the required 115-volt, single-phase operating voltage. Under normal operating conditions, when power is applied to the HSI, the OFF flag will disappear from view. When power is removed from the HSI, or power is lost, the OFF flag will come into view.

Compass Card

1.178 The compass card indicates the INU-derived magnetic heading of the aircraft.

NOTE

In the event of CIU failure, the rear seat compass card (TA-4) will be frozen at 360°.

TO/FROM Arrow

1.179 The TO/FROM arrow indicates whether the aircraft is approaching or departing the selected destination. When this arrow is pointing in the direction of the course pointer, it indicates the TO condition (approaching the selected destination). When the arrow opposes the course pointer, it indicates the FROM condition. The information displayed by the TO/FROM arrow is determined by the position of the COURSE and REFERENCE switches on the NAV panel.

Course Set Knob

1.180 The course (CRS) set knob (when enabled) positions the course pointer and the corresponding course display. This knob is enabled when NAVAID or OFFSET NAVAID is selected on the REF switch of the NAV panel or when NAS is selected on the REF switch and FIXED is selected on the CSE switch. When rotated it selects the desired magnetic course.

Course Deviation Bar

1.181 The course deviation bar indicates deviation from course. To acquire the course, the pilot should steer the aircraft toward the bar. The course to which the deviation bar is referenced is determined by the position of the COURSE and REFERENCE switches on the NAV panel.

Miniature Aircraft Symbol

1.182 The miniature aircraft symbol represents the aircraft nose, wings, and tail. It is fixed in position and indicates the aircraft direction of flight.

Heading Set Knob

1.183 The heading (HDG) set knob is mechanically coupled to the heading marker and positions the heading marker around the compass card.

Course Deviation Bar Alarm Flag

1.184 The deviation bar alarm flag is a combination warning and display mode indicator. This flag has three states; black, white with black diagonal bars, and white with the letters DF displayed. When ADF is selected on the ARC-159 control panel, this flag is in the white state with the letters DF displayed. When ADF is not selected and the course deviation bar data is valid, this flag is black. When a failure condition exists so that the validity of the course deviation data is questionable, this flag is white with black diagonal bars.

Course Pointer

1.185 The course pointer indicates the selected course. The information displayed by the course pointer is determined by the position of the COURSE and REFERENCE switches on the NAV panel.

Distance Display

1.186 The distance display indicates distance in miles by means of a three-digit numeric readout. A distance shutter covers the numeric display when the distance information currently driving the distance display is invalid. The information displayed by the distance display is determined by the position of the COURSE and REFERENCE switches on the NAV panel.

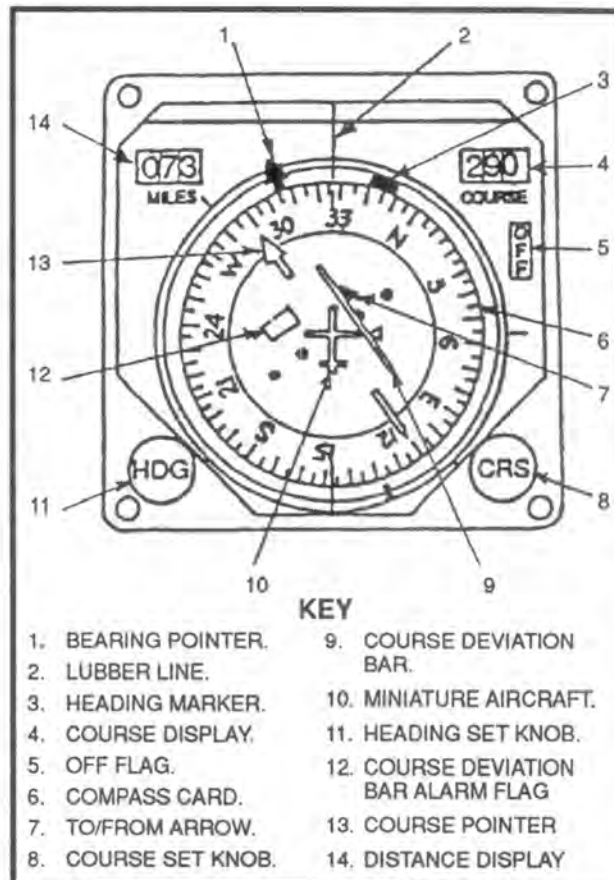


Figure 1-24 HSI Indicators and Controls

RADAR ALTIMETER

1.187 The AN/APN-194 radar altimeter is an RF pulse radar system which provides an indication of aircraft height above ground level through a range of 0 to 5000 feet. This information is used for navigation and weapon delivery.

1.188 Operation is based on precise measurement of the time required for an RF pulse to travel from the aircraft to the surface (land or water) over which the aircraft is flying and be reflected back to the aircraft.

1.189 When power is applied to the radar altimeter, a 3-minute warmup period is initiated. Radar altitude invalid is annunciated on the HUD during this warmup time. Following warmup, the transmitted RF pulses are reflected by the ground/water and detected by the receiver, and a range is computed. Radar altitude is blanked out above 5000 feet or whenever an invalid signal is received.

RAD ALT Switch

1.190 The RAD ALT switch (Figure 1-25), located on the main instrument panel above the fuel flow indicator is a three position switch that controls power to the Radar Altimeter. The three switch positions are:

- a. **RAD ALT** Radar Altimeter ON. CIU uses RAD ALT information for navigation computation, low altitude warning and HUD,
- b. **WPNS** Radar Altimeter ON. CIU uses RAD ALT information for navigation computation, low altitude warning, HUD, and **weapon delivery**, if radar air to ground ranging is unavailable.
- c. **OFF** Radar Altimeter OFF.



Figure 1-25 RAD ALT Switch

LAWS Warning

1.191 With height above ground information being supplied by the radar altimeter, an aural warning is provided when the aircraft flies below a RAD ALT setting inserted via the UFC. The RAD ALT setting, which is defined as the height AGL below which the pilot needs to be warned, is inserted on the RAD ALT page on the HUD scratch-pad. If the aircraft descends below this inserted value, the LAWS tone generator issues an aural warning tone for 2 seconds. The altitude warning tone is an alternating 700 to 1700 Hz tone at a 2 Hz repetition rate monitored through the pilot's headset. Additionally, HUD RAD ALT display is flashed at 3 Hz whenever the aircraft is below the preset altitude. Once the 2-second aural warning tone has been issued and the RAD ALT setting is not changed, the tone is not issued again unless the aircraft climbs above the RAD ALT setting and descends below it again. The last entered RAD ALT setting is retained, even during shutdown periods.

Self Test

1.192 When radar altimeter BIT is commanded by the CIU (I-BIT) with the aircraft on the ground, the reflected RF signal is blanked to the receiver, and an artificial target (at 100 feet) is inserted. If the receiver-transmitter functions normally, the radar altitude on the HUD will indicate 100 ± 15 feet. If the receiver-transmitter is malfunctioning, the radar altitude on the HUD is blanked and a radar altimeter failure is indicated on the Pilot's fault list.

ANGLE OF ATTACK SYSTEM

1.193 The angle-of-attack system consists of an angle-of-attack vane transducer unit, and an indexer lights assembly with dimming wheel. The angle-of-attack vane, mounted on the left side of the forward fuselage, senses the relative airflow. This information is sent through the DADC to the CIU. The CIU processes AOA information for display on the HUD. AOA information is also sent direct from the vane to a relay unit in the aircraft nose and then used to light the AOA indexers. The angle-of-attack vane is not heated when operating on emergency generator with the landing gear extended.

Angle-of-Attack Indexer Lights

1.194 The angle-of-attack indexer lights assembly, located above the cockpit glareshield and left of the HUD is a single case containing three light bulbs behind a red Polaroid lens. Angle-of-attack indications are shown on the light assembly by a chevron (V) at the top, a doughnut at the centre and an inverted (A) chevron at the bottom. Two intermediate conditions are also indicated on the lens, when approaching or departing optimum angle of attack, by showing the (O) simultaneously with the (V) or (A) display. (See Figure 1-26 for concise interpretation of INDEX CONDITIONS). The light bulbs in the indexer are electrically connected through a dimming mechanism within the case to the index light transformer. Dimming of the lights is controlled by manual movement of a wheel, protruding from the face on the left side of the case, to provide suitable intensity for the pilot. Dimming is automatically provided when the exterior lights are turned ON.

1.195 A press-to-test button on the indexer lights assembly is used to check the integrity of the bulbs. Provided the gear is down, and weight off wheels, all three bulbs will illuminate when the button is pressed. Alternatively, all three bulbs will illuminate whenever the Master Press-To-Test button is pressed.

AL 8(0)

HUD AOA Display

1.196 The aircraft angle-of-attack is displayed on a vertical scale on the left side of the HUD display. This scale shows AOA from 0 to 30 units with dots at every 5 units. (These increments are not absolute but are arbitrary indicated units grouped around the optimum). A horizontal bar shows the stall AOA at 27 units, and optimum is shown by a bracket at 16.5 units (TA-4) and 17.5 units (A-4). The current value of AOA is represented on the scale by a right-pointing caret (>) on the left of the scale.

1.197 If the optimum AOA indication does not produce the proper IAS, as computed from Chapter 2 paragraph 2.50 Rejoin Checks, the pilot should check flap position to ensure that the aircraft is in the proper configuration. The pilot should determine which source of information is correct by observing the position of the wing slats. Slats should be approximately one-half extended at approach speed, gear and flaps down.

1.198 The angle-of-attack system may be used for cruise control if the airspeed system fails. It should be recognized that the angle-of-attack indications are inadequate to use as a prime cruise control system, since small variations result in relatively large changes in airspeed at optimum cruise. Sample angle-of-attack readings for this are indicated in Table 1-5.

	ANGLE-OF ATTACK TOO HIGH
	ANGLE-OF ATTACK HIGH APPROACHING OR DEPARTING OPTIMUM
	ANGLE-OF ATTACK OPTIMUM
	ANGLE-OF ATTACK LOW APPROACHING OR DEPARTING OPTIMUM
	ANGLE-OF ATTACK TOO LOW

Figure 1-26 Index Conditions**Table 1-5 AOA Cruise Control**

Condition	HUD AOA Indication	
	A-4	TA-4
Maximum rate climb	4.5 to 9.5	4.5 to 9.0
Maximum range descent or maximum endurance at all altitudes	10.8	10.5
Cruise at 5000 feet	6.8 to 7.1	6.6 to 7.0
Cruise at 35,000 feet	8.0 to 9.3	7.7 to 9.0
250-knot descent with speedbrakes extended	7.0*	

*Gross weight of 14,000 pounds. Add/subtract 0.35 units for each increase/decrease of 1000 pounds weight. Valid for all configurations.

1.199 The above data is based on an aircraft configured with two 300-gallon external tanks. For clean aircraft, these angle-of-attack indicator readings should be decreased 1.0 unit, 0.6 units for the cruise, and rate-of-climb (TA-4).

NOTE

When above speeds of 200 KIAS, an angle-of-attack error of 0.5 unit can be equal to an airspeed error of 25 KIAS or more.

IDENTIFICATION FRIEND OR FOE (IFF)

1.200 The APX-100 (V) IFF is capable of automatically reporting coded identification and altitude signals in response to interrogations from surface or airborne stations, so that the stations can establish aircraft identification, control air traffic, and maintain vertical separation.

1.201 The system has five operating modes. Modes 1 and 2 are IFF modes. Mode 3 (civilian Mode A) and Mode C (automatic altitude reporting) are primarily air traffic control modes. When fitted, Mode 4 is secure, encrypted IFF mode.

1.202 The Mode 4 KIT-1C/TSEC Transponder is a Controlled Cryptographic Item (CCI). Standard procedures for the handling of Communications Security (COMSEC) Equipment are to be adhered to during the operation of the AN/APX-100(V) IFF Mode 4 system.

AL 8(0)

1.203 The IFF system comprises the following components:

- Controller, C-10009
- Receiver-Transmitter, RT-1157B/APX-100(V)
- Mode 4 Transponder Computer, KIT-1C/TSEC
- Two Antennas
- IFF Glareshield Warning Light

Controller

1.204 The C-10009 Controller (Figure 1-27) provides all necessary controls and indications for applying power to the IFF system, selecting the modes of operation, and monitoring the reply in some of the modes. The Controller is installed in the right hand console of the cockpit. Panel illumination is provided by fifteen lamps mounted on a printed circuit board behind the front panel.

TA-4 AIRCRAFT ONLY

There is no Controller fitted in the aft cockpit of the TA-4.

1.205 The operation of the controls and indicators on the IFF Controller are as follows:

NOTE

With the MASTER switch in any position, other than OFF, the IFF will continue to operate on the ground. The retraction release switch system only disables IFF Mode 4.

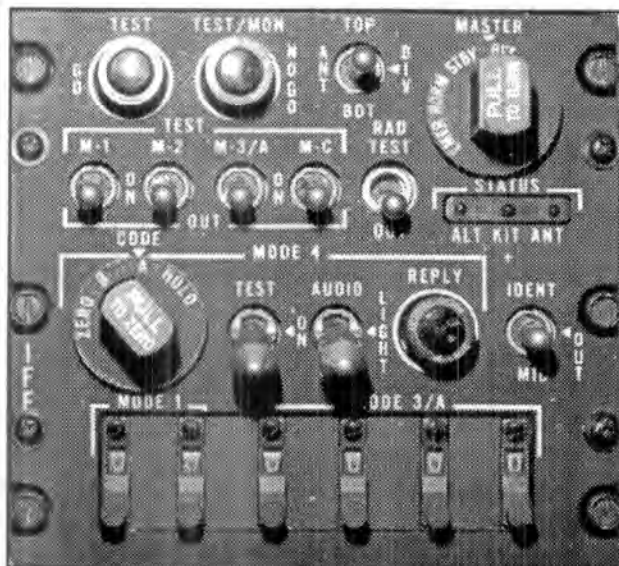


Figure 1-27 C-10009 IFF controller

NOTE

The controls above the code selector switches, except the IDENT/MIC/OUT switch, are used for secure Mode 4 operations when a KIT-1C/TSEC Computer is fitted and the Receiver-Transmitter has been adapted for Mode 4.

MASTER Switch

1.206 This is a five position rotary switch, used to turn the IFF system on and off, and select emergency operation. To prevent accidental switching to the emergency (EMERG) or OFF position, the switch knob must be pulled out (lifted) before it can be turned to either of these positions. Standby (STBY) should be selected for 2 minutes prior to switching to NORM, to allow the Receiver-Transmitter to warm up. Mode 4 will not work if the switch position is OFF or STBY.

NOTE

If Mode 4 codes are set in the KIT-1C/TSEC Computer, placing the MASTER switch to OFF after operation of the retraction release switch (ie. post flight) will zero these codes, unless these codes have been retained using the CODE switch.

RAD TEST/OUT/MON Switch

1.207 Used to test and monitor the operation of Modes 1, 2, 3/A and C. The spring-loaded RAD TEST position is used to allow testing of Modes 3/A and 4 using an external test set.

M-1, M-2, M-3/A and M-C Switches

1.208 These are used to select or test Modes 1, 2, 3/A, and C. The ON and OUT positions will select or deselect each mode. The spring-loaded TEST position initiates BIT in the selected mode to check the operation of the Receiver Transmitter in each mode. When the switch for one of the modes is momentarily placed to TEST, proper operation of that mode is displayed when the TEST GO indicator illuminates. If the self test fails for that particular mode then the TEST/MON NO-GO indicator lights. The MASTER switch must be set to NORM, and the switches of the modes not being tested should be placed to OUT, to prevent unnecessary interference with nearby ground stations.

NOTE

To enable the system to reply in Mode C, the M-3/A switch also has to be enabled. This is a function of the circuitry in the Receiver-Transmitter.

Mode 1 Selector Switch

1.209 The two push button selector switches allow selection of any of the 32 codes for Mode 1 operation.

Mode 3/A Selector Switch

1.210 The four push button selector switches allow selection of any of the 4096 codes for Mode 3/A operation.

IDENT/OUT/MIC Switch

1.210a A three position toggle switch which adds an identification of position (I/P) pulse to replies in Modes 1, 2, and 3/A for a period of 15 to 30 seconds. The IDENT position is spring-loaded for momentary use, while the MIC position adds the I/P pulse whenever the radio microphone is keyed.

Mode 4 TEST/ON/OUT Switch

1.210b This is used to select or test Mode 4. The ON and OUT position will select or deselect each mode and the spring-loaded TEST position initiates self test Mode 4. The handle shape is designed to be recognized by touch. To prevent accidentally switching Mode 4 off, the handle must be lifted before it can be set to the OUT position.

CODE Switch

1.210c This is a four position rotary switch used to select the type of Mode 4 operation. It can also be used to erase or retain the codes set in the KIT-1C/TSEC Computer. The switch is spring-loaded to return to A from the HOLD position. The Computer can have two sets of Mode 4 codes inserted into it, and these are accessed by setting the CODE switch to A or B as required. The codes can be zeroed any time the aircraft power is on and the MASTER switch is not OFF. To prevent accidental erasure of the Mode 4 codes, the knob must be pulled out before it can be rotated to the ZERO position. If the Mode 4 codes need to be retained in the Computer, after the flight while power is removed from the aircraft, the CODE switch must be rotated to the HOLD position and released at least 15 seconds before the MASTER switch or aircraft power is turned off.

AUDIO/OUT/LIGHT Switch

1.210d This is a three position toggle switch used to select the method of monitoring Mode 4 operation. The handle shape is designed to be recognized by touch. In the LIGHT position, the REPLY indicator will illuminate if Mode 4 replies are being transmitted. In the AUDIO position an audio tone in the pilots headset indicates that valid Mode 4 interrogations are being received, and the REPLY indicator will illuminate if Mode 4 replies are being transmitted. In the OUT position, the audio indications and the REPLY indicator are inoperative, and the REPLY indicator will not press-to-test.

TEST GO, TEST/MON NO-GO and REPLY Indicators

1.210e The operation of these indicators is covered in paragraphs 1.208 and 1.210d. All are press-to-test types, and operation can be checked by pressing the cap in and ensuring the indicator illuminates. The indicator may also be dimmed by turning the cap clockwise. The TEST/MON NO-GO light will illuminate when monitor circuits in the Receiver-Transmitter detect that the system is not operating properly.

ALT, KIT, and ANT Status Indicators

1.210f These give an indication which unit is faulty when monitor circuits in the Receiver-Transmitter detect a fault. The ALT Status Indicator is not used in the Skyhawk system. The KIT Status Indicator, when illuminated, indicates a malfunction in the Mode 4 computer. The ANT Status Indicator, when illuminated, indicates a fault in the antennas.

ANT TOP/DIV/BOT Switch

1.210g A three position toggle switch which allows selection of either top or bottom antennas. In the DIV position allows normal diversity to take place.

Receiver-Transmitter

1.210h The RT-1157B/APX-100(V) Receiver-Transmitter (Figure 1-27NO TAG) is the main unit of the IFF and is located in the aft avionics bay.

1.210i The Receiver-Transmitter has what is known as a diversity feature. A separate receiver is used for each antenna. A module in the unit compares the output signal levels and replies only from the antenna receiving the strongest signal. The range of the Receiver-Transmitter is limited to line of sight transmission, since its frequency of operation is in the UHF band, making range dependent on the altitude of the aircraft.

1.210j The operation of the controls and indicators on the Receiver-Transmitter is as follows.

AL 8

Mode 2 Selector Switch

1.210k The four push button selector switches allow selection of any of the 4096 codes for Mode 2 operation.

Elapsed Time Indicator

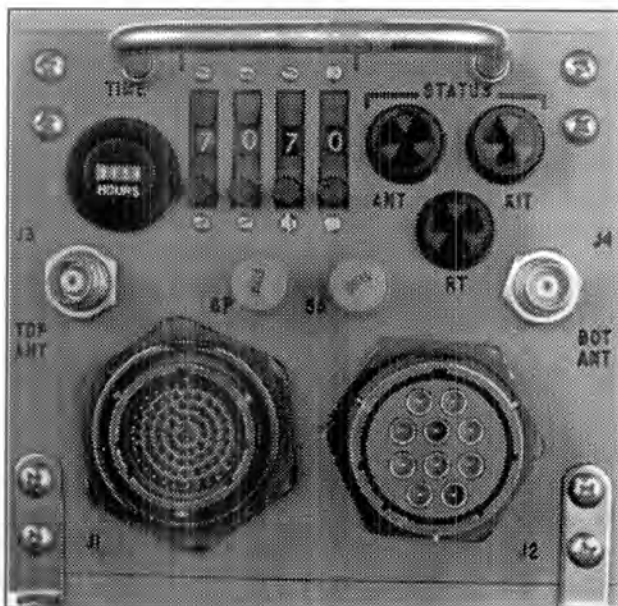
1.210l Displays the total time that Mode 2 has been selected on.

Mode 4 Transponder Computer

1.210m When fitted the KIT-1C/TSEC transponder computer is located in the aft avionics bay. Its function is to electronically authenticate the Mode 4 interrogations and, if it is compatible, generate properly time-coded Mode 4 replies. The KIT-1C/TSEC stores two keys (codes) in memory that are used to decrypt Mode 4 challenges. Key A is used for the current day's operations, and Key B is used for the next day (after 2400Z). The system has several features to protect the stored keys from being compromised. These design features automatically zeroise the stored keys if the unit is opened, or if the system power is lost for more than 10 seconds. In addition, the keys may be zeroised manually, by pressing the KIT-1C/TSEC front panel ZEROISE switch, or remotely from the controller.

Antenna

1.210n The antennas are used to receive interrogation signals, and transmit the reply signals. The forward antenna is located on the upper surface of the nose electronic equipment section. The aft antenna is located in the upper portion of the fin tip.



**Figure 1-27a RT-1157B/APX 100(V)
Receiver-Transmitter**

IFF Glareshield Warning Light

1.210o The IFF Glareshield Warning Light will illuminate when the KIT-1C/TSEC transponder computer is fitted and Mode 4 is operational and;

- the aircraft is being interrogated but does not reply, or
- a fault exists in the KIT-1C/TSEC Transponder Computer, or
- the code in the KIT-1C/TSEC transponder computer has been zeroised.

1.210p If the IFF glareshield warning light illuminates, the position of the CODE switch on the IFF controller and the KIT status indicator should be checked.

System Interfaces

Altimeter

1.210q The AAU-32/A encoding altimeter continuously sends coded altitude information to the IFF Receiver-Transmitter for transmission when Mode C is selected on the controller. This enables the interrogating station to determine aircraft height.

Tacan and Radar Warning System

1.210r The IFF Receiver-Transmitter supplies a suppression (blanking pulse) to the ARN 118 Tacan and the ALR-66(VE) Radar Warning Processor during IFF operations. The purpose of the suppression pulse is to inhibit interference to the Tacan and Radar Warning system.

Audio

1.210s When Mode 4 is being aurally monitored, the audio output from the IFF is fed to the Audio Junction box. From the Audio Junction box the signal is fed to both the audio panel and the alternate amplifier. The volume of the IFF tone is not adjustable on the audio panel.

AUTOMATIC FLIGHT CONTROL SYSTEM

INTRODUCTION

1.211 The Automatic Flight Control System (AFCS) is a transistorized system utilising a single channel digital computer to relieve the pilot of hands on control of the aircraft during long range transits, airways navigation etc. The AFCS will maintain selected headings and altitudes, or pitch and bank angles, perform co-ordinated turns onto a preselected heading, intercept and maintain NAS programmed routes, or intercept bearings to or from selected nav aids. The Control Stick Steering mode enables the pilot to manoeuvre the aircraft hands on, performing unlimited manoeuvres within the AFCS envelope without having to disconnect the AFCS. Directional stability augmentation is active during AFCS operation or can be selected separately while on normal flight control. Stability augmentation provides yaw damping through the rudder independent of pilot movement of the rudder pedals.

1.212 Safety features are provided which utilise software and hardware monitors to detect failures and then disengage the appropriate AFCS function. This design prevents system malfunctions from damaging the aircraft or displacing ailerons excessively. Built in Test modes are provided for pilot initiated pre flight testing and these provide continuous inflight monitoring of the AFCS for post flight maintenance action.

1.213 Operating modes are selected through either the AFCS Control panel or via the Display Unit softkeys. These send electrical signals to the Digital Flight Control Computer (DFCC) which contains the flight control logic for each of the operating modes. DFCC electrical outputs are then converted to mechanical signals by hydraulic servos which drive the aircraft control surfaces. The hydraulic servos require utility system hydraulic power.

1.214 The AFCS is an electrohydraulic system requiring all three phases of 115/200 VAC, 400Hz and 38 VDC power. Normal hydraulic system pressure of 3000 psi is reduced to 1500 +75, - 50 psi for the aileron and elevator servos, and to 1150 +450, - 50 psi for the dual input rudder valve. The AFCS will not operate on the emergency generator and will not engage unless proper electrical and hydraulic power is available. It will automatically disengage if electrical or hydraulic power is lost.

AFCS OPERATING ENVELOPE

1.215 At altitudes of 7500 feet and above, operation of the AFCS is unrestricted. Refer to Chapter 4, Table 4-4 for restrictions below this altitude. Stability augmentation operation is unrestricted throughout the aircraft flight envelope.

AFCS CONTROL PANEL

1.216 The AFCS control panel (Figure 1-28) is located on the forward left console.

STANDBY Switch

1.217 Movement of the STANDBY switch to **STANDBY** provides electrical power to the AFCS and DFCC for warm-up and automatic controls synchronization to prevent engage transients. The switch should be in **STANDBY** at least 90 seconds prior to engaging the stability augmentation switch or the AFCS main engage switch. When this switch is placed in the **OFF** position, all toggle switches on the panel return to the **OFF** position, and NAS coupled steering toggles to **OFF**.

Stability Augmentation Switch

1.218 Yaw damping action is provided when the ENGAGE switch is in the ENGAGE position or the STABILITY AUGMENTATION switch is in the STAB AUG position.

ENGAGE Switch

1.219 Movement of the ENGAGE switch to the **ENGAGE** position turns on the AFCS and provides yaw stability augmentation. With stick force less than 2 pounds one of two modes is entered as follows:

1.220 In addition, the pilot can further select any one of three other modes: altitude hold; preselect heading; or NAS-coupled steering. NAS-coupled steering utilises one of three references depending on the position of the NAS reference switch: a NAS route structure; a tuned nav aid; or an offset nav aid.



Figure 1-28 AFCS Control Panel

AL 8(0)

1.221 The **ENGAGE** switch may be placed in the **OFF** position at any time. The switch should not be placed in the **ENGAGE** position until the standby switch has been in the **STANDBY** position for 90 seconds.

1.222 When the **ENGAGE** switch is placed in the **OFF** position the heading select switch and the altitude switch return to the **OFF** position and NAS-coupled steering toggles to **OFF**.

Heading Select Switch

1.223 The HDG SEL switch is operational only when the ENGAGE switch is in the **ENGAGE** position. Movement of the HEADING SELECT switch to the **HDG SEL** position starts the aircraft turning by the shortest route toward the heading selected on the heading select indicator by use of the SET knob. The HEADING SELECT switch may be placed in the **OFF** position at any time. If placed in the **OFF** position prior to completion of the turn, the aircraft will roll smoothly to a level attitude and maintain the compass heading indicated at the time the switch was deselected. The SET knob may be turned at any speed in either direction whilst the aircraft is turning without causing any abrupt aircraft lateral movement. Selection of a heading reciprocal to the present aircraft heading will cause the aircraft to smoothly reverse the turn. The HDG SEL switch will automatically move to the **OFF** position if the control stick steering mode is engaged by a stick force > 2 pounds or the ENGAGE switch is selected **OFF**.

1.224 Engaging the HDG SEL switch does not affect pitch, i.e. the approximate pitch attitude will be maintained throughout the turn. If a level turn is desired, the altitude hold mode should be engaged by moving the altitude hold switch to **ALT**.

Altitude Switch

1.225 Movement of the ALTITUDE switch to the **ALT** position causes the aircraft to maintain the baro-inertial altitude at actuation. If the mode is engaged during a climb or dive, the aircraft will return to the baro-inertial altitude existing at the time of ALTITUDE switch engagement. The ALTITUDE switch cannot be engaged when rate of climb or descent exceeds 4000 feet per minute. The mode cannot be engaged while any force is being applied to the control stick. The switch will move automatically to the **OFF** position whenever control stick steering mode is engaged by applying a stick force of 2 pounds or more.

Aileron Trim Switch

1.226 The AILERON TRIM switch has two positions: **NORM** and **EMER**. This switch is usually in the **NORM** position but may be placed in the **EMER** position to provide aileron trim after the AFCS is disengaged, if aileron trim is not available in **NORM**. Movement of this switch to the **EMER** position also disengages and prevents

re-engagement of the AFCS, except stab aug, while in the **EMER** position. The AFCS can be re-engaged after placing the switch back to the **NORM** position.

CONTROL STICK

Autopilot Disconnect Button

1.227 The control stick (Figure 1-29) has an AFCS disconnect button labelled **AP**. Pressing this button immediately disengages the entire AFCS including stab aug. All switches, except for **STANDBY**, return to **OFF**.

Sensor

1.228 Within the control stick is a force sensor which transmits signals representing pilot-applied stick forces to the DFCC.

Control Stick Trim Switch

1.229 The CONTROL STICK TRIM switch is used to trim the aircraft in roll and pitch during non-AFCS operations. It is inoperative during all AFCS modes except control stick steering. In the control stick steering mode, the roll trim signal causes an output from the DFCC, which then activates the aileron power mechanism, and not the aileron trim tab motor as in normal control system use. All pitch trim signals operate the horizontal stabilizer, whether in control stick steering mode or using normal flight controls.

NOTE

The CONTROL STICK TRIM switch should be used in the normal manner when control stick steering mode is engaged. Transients are minimized during disengagement or re-engagement of control stick steering if the aircraft is correctly trimmed at the time.

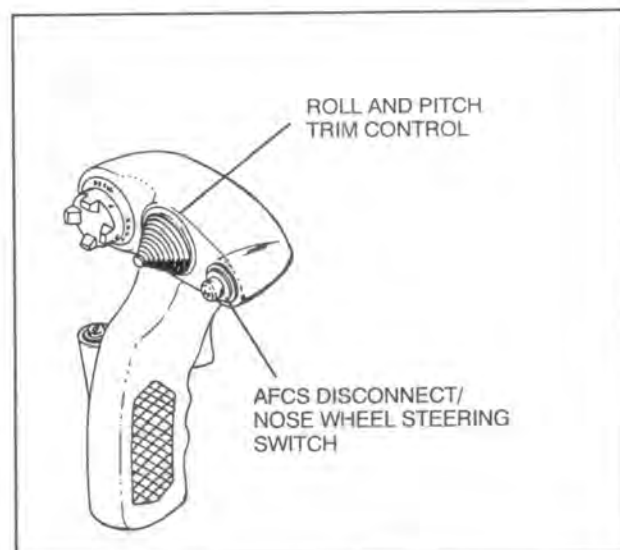


Figure 1-29 Control Stick

AL 8(0)

AFCS MODES

1.230 The AFCS has:

- a. One yaw mode – **Stability Augmentation;**
- b. Two pitch modes – **Pitch Attitude Hold, Altitude Hold;**
- c. Four roll / lateral modes – **Bank Attitude Hold, Heading Hold, Preselect Heading, NAS-Coupled Steering;**
- d. and a **Control Stick Steering** mode.

Stability Augmentation Mode

1.231 The stability augmentation mode provides rudder yaw damping action and is independent of pilot movement of the rudder pedals. This mode is active when either the ENGAGE switch is in the **ENGAGE** position or the STAB AUG switch is in the **STAB AUG** position. The pilot must trim the aircraft directionally while using the AFCS in the same manner as he would when using the normal flight control system. If the aircraft is out of trim directionally, the following will occur:

- a. A lateral engage transient will occur during change to the control stick steering mode.
- b. The aircraft will be in a steady heading side slip in the heading hold mode.

Pitch Attitude Hold Mode

1.232 With an aircraft bank angle less than 70 degrees and a pitch angle less than 60 degrees noseup or nosedown, the aircraft pitch attitude at time of engagement of the AFCS or reversion from the CSS mode will be maintained. Additionally, to enter this mode, stick force must be less than 2 pounds, and altitude hold must be **OFF**.

Altitude Hold Mode

1.233 The altitude hold mode maintains the baro-inertial altitude that existed at engagement. This mode may only be engaged when the aircraft rate-of-climb or descent is less than 4000 ± 500 feet per minute. At engagement the AFCS automatically pulls the aircraft out of any climb or dive and returns it to maintain the engaged altitude within a steady state accuracy of ± 30 ft or 0.1%, whichever is greater.

Bank Attitude Hold Mode

1.234 If the pitch angle is less than 60 degrees noseup or nosedown and the bank angle of the aircraft is between 5 degrees and 70 degrees upon engagement of the AFCS or reversion from CSS mode, the aircraft will maintain the bank attitude that existed at engagement. Additionally, stick force must be less than 2 pounds, and neither the NAS-coupled steering mode nor the preselect heading mode must be active.

Heading Hold Mode

1.235 If the pitch angle is less than 60 degrees noseup or nosedown and the bank angle of the aircraft is less than 5 degrees upon engagement of the AFCS or reversion from CSS mode, the aircraft will be rolled to a level attitude and the heading and pitch angles at that time will be maintained. Additionally, stick force must be less than 2 pounds, and neither the NAS-coupled steering mode nor the preselect heading mode must be active.

1.236 This mode is also entered upon deselecting the NAS-coupled steering mode or the preselect heading mode, even if the bank angle at the time of deselection is greater than 5 degrees. If this is the case, the AFCS rolls the aircraft out then begins a turn to acquire the heading at the time of deselection.

Table 1-6 AFCS Engage Modes

Flight Condition	Active Mode
5–70° Angle of Bank, and $\pm 60^\circ$ Pitch	Pitch and Bank Attitude Hold
Less than 5° Angle of Bank, and $\pm 60^\circ$ Pitch	Pitch and Heading Hold

Preselect Heading Mode

1.237 Upon engagement of this mode, the aircraft rolls into a smooth turn in the direction of the shortest route to the heading shown on the heading select indicator, and then rolls out to maintain this heading. The bank angle is limited to 27.5 degrees under all conditions.

NOTE

If the preselect heading mode or the NAS-coupled steering mode is selected below airspeeds ranging from 160 KIAS at 10,000 feet to 200 KIAS at 40,000 feet the bank angle of 27.5 degrees may cause the aircraft to buffet in an approach to the stall.

AL 8(0)

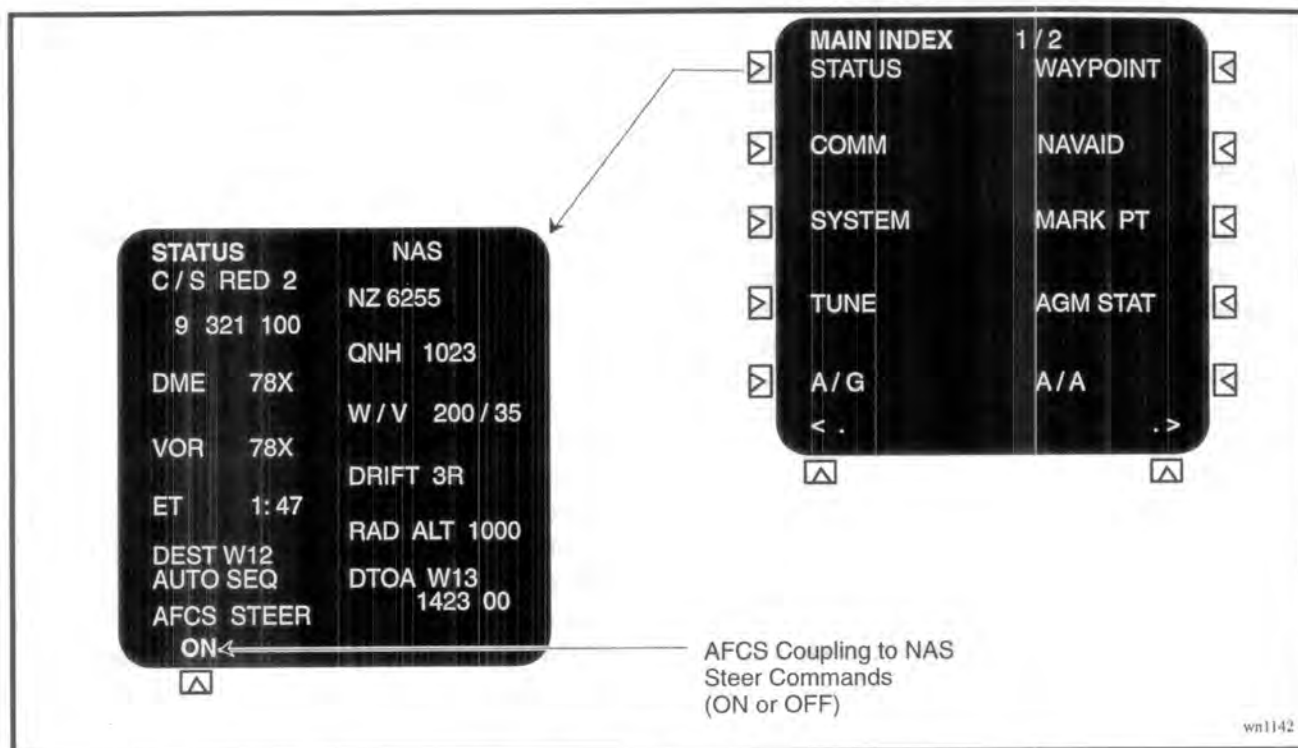


Figure 1-30 AFCS Steer Selection

NAS-Coupled Steering Mode

1.238 In the NAS-coupled steering mode the DFCC controls the ailerons to follow NAS commanded steering inputs. The NAS uses inputs from the Inertial Navigation Unit and selected Navaids to compute Track Angle Error for the current NAS mode. This TAE signal is fed to the DFCC which uses it to keep the aircraft on the desired track. This allows the AFCS to fly the aircraft throughout a flight plan including automatic sequencing at waypoints.

1.239 NAS-coupled steering is available in A/A, NAV, and A/G master modes using either NAS, NAVAID, or OFFSET NAVAID as a steering reference with the sole exception of NAVAID when an ILS frequency is tuned, since no TAE is generated for this approach.

1.240 Aircraft response in this mode will be identical to normal AFCS operation, in that the angle of bank is limited to 27.5 degrees.

1.241 NAS-coupled steering is engaged by selecting the AFCS ENGAGE switch to **ENGAGE** and toggling the AFCS STEER option on the DU STATUS page to **ON** (Figure 1-30) using the key immediately below the AFCS STEER legend. Provided a valid TAE signal is available the NAS-coupled mode will then be engaged. This will be indicated to the pilot in the HUD by the steering caret below the heading scale changing to a double caret (Figure 1-31).

1.242 The AFCS STEER automatically toggles to **OFF** whenever any of the following conditions are met:

- ENGAGE switch is selected **OFF**.
- TAE signal is invalid (e.g., an ILS frequency is tuned in NAVAID mode).
- Pilot overrides the control stick with 2 or more pounds force.
- HEADING SELECT switch is moved to the **HDG SEL** position.
- Pilot presses the AFCS disconnect button on the control stick.
- AILERON TRIM NORM-EMER switch is set to **EMER**.
- Standby switch is set to **OFF**.

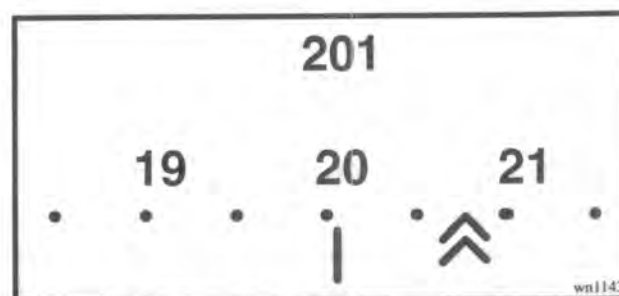


Figure 1-31 HUD Heading Scale with AFCS STEER Caret

Control Stick Steering Mode

1.243 The CSS mode provides for pitch and roll control of the aircraft through the AFCS by pilot movement of the stick as in normal flight. This mode is engaged, regardless of other modes selected or in operation, by applying a force on the control stick grip of 2 pounds or more. Preselect heading, altitude hold, and NAS-coupled steering modes are disengaged by use of CSS and must be re-engaged to be used again. The AFCS reverts from CSS mode to either pitch and bank attitude hold, or pitch and heading hold mode when pilot force on the control stick is reduced below 2 pounds. The aircraft is controllable in all attitudes in CSS throughout the AFCS flight envelope, which is 4.0 ± 0.5 positive g, 1.5 ± 0.5 negative g, and one-half aileron deflection left or right. With a centreline store installed the load factor limits are reduced to 3.5 ± 0.5 positive g, 1.0 ± 0.5 negative g. If these limits are exceeded, the AFCS disengages.

1.244 The AFCS will not switch out of CSS at bank angles exceeding 70 degrees or pitch angles exceeding 60 degrees noseup or nosedown unless limits of acceleration or aileron deflection are exceeded.

CAUTION

The control stick should not be released while in CSS if the push-or-pull force at the time exceeds 12 pounds because of large disengage transients. These transients are minimized if the aircraft is properly trimmed at the time of release.

AUTOMATIC SAFETY FEATURES

1.245 The DFCC provides safety features which function automatically to disengage the AFCS given the detection of a failure. Software and hardware monitors check the validity of INU, airspeed and altitude outputs; and look for pitch trim runaway, servo failure, or hardover conditions. The following major safety features are incorporated.

Aircraft Structural Protection

1.246 The AFCS is automatically disengaged and the ENGAGE switch moved to OFF when normal load factor exceeds 4 ± 0.5 positive g or 1.5 ± 0.5 negative g; or if aileron deflection exceeds 20 degrees (one-half lateral stick displacement) from neutral. Load factor limits are reduced to 3.5 ± 0.5 positive g or 1 ± 0.5 negative g when a centreline store is carried.

AFCS Temporary Overpower

1.247 The AFCS can be temporarily overpowered in pitch and roll. Pilot application of 15 pounds elevator stick force will overpower AFCS pitch control without affecting AFCS roll or yaw control. Similarly a 35 pound aileron stick force will overpower the AFCS roll control without

affecting pitch or yaw control. The AFCS remains overpowered as long as the required stick force is applied.

NOTE

The only time to use the overpower feature would probably be to counteract a failure within the AFCS that caused large aileron or elevator deflections. Unless prevented by such a failure, the AFCS will engage CSS mode when the stick force is applied, and will disengage this mode when the stick force is reduced below 2 pounds.

AFCS Lateral Hydraulic Disengage

1.248 AFCS lateral control can be disengaged by applying an abrupt aileron stick force of 40 pounds. This will cause the aileron servo to bypass, effectively disengaging AFCS lateral control, and enabling the pilot to provide roll control through the normal system without affecting AFCS pitch control. The engage switch will not move from the ENGAGE position. AFCS lateral control can be re-engaged at any time by cycling the ENGAGE switch to OFF then back to the ENGAGE position.

Control Stick Disengage

1.249 Pressing the AP button on the control stick will disconnect the AFCS electrically. The AFCS can be reengaged in the normal manner.

PREFLIGHT TEST PROCEDURE

AFCS #1 Test

1.250 The AFCS #1 test is an autopilot disengage test. During this test the logic prohibiting the AFCS from being engaged on the ground will be temporarily overridden. Each activation of this test provides 10 seconds of override.

1. DU Press IDX
Select →
2. DU Select AFCS #1

1.251 Perform the following actions in less than 10 seconds and observe the ENGAGE switch returns to the OFF position each time.

3. AFCS ENGAGE switch ENGAGE
4. Control stick AP switch. Press
5. AFCS ENGAGE switch ENGAGE
6. Control stick Deflect to left
7. AFCS ENGAGE switch ENGAGE
8. Control stick Deflect to right
9. AFCS ENGAGE switch ENGAGE
10. AILERON NORM-EMERG
switch EMERG

AFCS #2 Test

1.252 The AFCS #2 test is an AFCS control and feedback test. This test performs control surface and control stick movements. Once initiated this test executes without pilot intervention. It may be initiated before AFCS #1 has timed out since it will override AFCS #1.

WARNING

During AFCS #2 testing, the DFCC will command control surface movements. Ensure cockpit personnel are aware there will be stick movements, and ground personnel and equipment are clear of the control surfaces: aileron, rudder, elevator, speedbrakes, and horizontal stabilizer. Movements should begin approximately 2 seconds after the test is initiated.

1. DU Press IDX
Select ->
2. DU Select AFCS #2

1.253 The AFCS ENGAGE switch must be placed in the ENGAGE position within 10 seconds of selecting AFCS #2. If not, AFCS #2 terminates and must be reselected to continue.

3. AFCS ENGAGE switch ENGAGE
4. The ENGAGE switch will drop to OFF at the completion of the test (approximately 2 minutes).

NOTE

The pilot must not change the position of any flight control during AFCS #2. Any inputs to rudder pedals, control stick, speedbrakes or trim may result in a test FAIL annunciation.

1.254 Testing can be stopped at any time by placing the AFCS STANDBY switch in the OFF position.

NORMAL IN-FLIGHT OPERATION

To Engage Stab Aug

1. STANDBY switch STANDBY
(90 second warmup period)
2. AILERON TRIM
EMERGENCY switch NORM
3. HEADING SELECT switch OFF

4. ALTITUDE switch OFF
5. ENGAGE switch OFF
6. STAB AUG switch STAB AUG

To Engage AFCS

1.255 Perform the above steps, then select the ENGAGE switch to the ENGAGE position.

NOTE

The ENGAGE switch may be selected to ENGAGE without first actuating STAB AUG. However, STAB AUG actuation is recommended first so that the pilot will have the STAB AUG mode available after selecting the ENGAGE switch to OFF on the AFCS control panel.

Engaging NAS-Coupled Steering

1. Engage the AFCS as above, selecting the ENGAGE switch to ENGAGE.
2. DU Press IDX
Select STATUS
3. AFCS STEER Toggle to ON

1.256 NAS-coupled steering is indicated by the word ON displayed under the AFCS STEER legend on the STATUS page, and the steering caret below the heading scale in the HUD becoming a double caret.

Disengaging NAS-coupled Steering

1. DU Press IDX
Select STATUS
2. AFCS STEER Toggle to OFF

NOTE

AFCS will automatically drop out of NAS coupled steering whenever any of the disengage conditions in paragraph 1.242 apply.

To Disengage AFCS

1.257 The pilot may disengage the AFCS by any one of the following actions:

1. Pressing control stick AP disconnect button.
2. Placing the STANDBY switch in the OFF position.
3. Placing both the ENGAGE and the STAB AUG switches in their OFF positions.
4. Placing the AILERON TRIM NORM-EMER switch in the EMER position

COCKPIT ENCLOSURE

INTRODUCTION

1.258 The cockpit enclosure consists of a fixed, three piece windshield and a hinged clamshell canopy. The canopy when closed and locked provides a pressurized enclosure to ensure proper environmental conditions during flight.

TA-4 CANOPY

1.259 The canopy is hinged behind the rear cockpit and is attached to a hydraulic actuator located between the cockpits. Under normal operating conditions, the utility hydraulic system actuates the canopy.

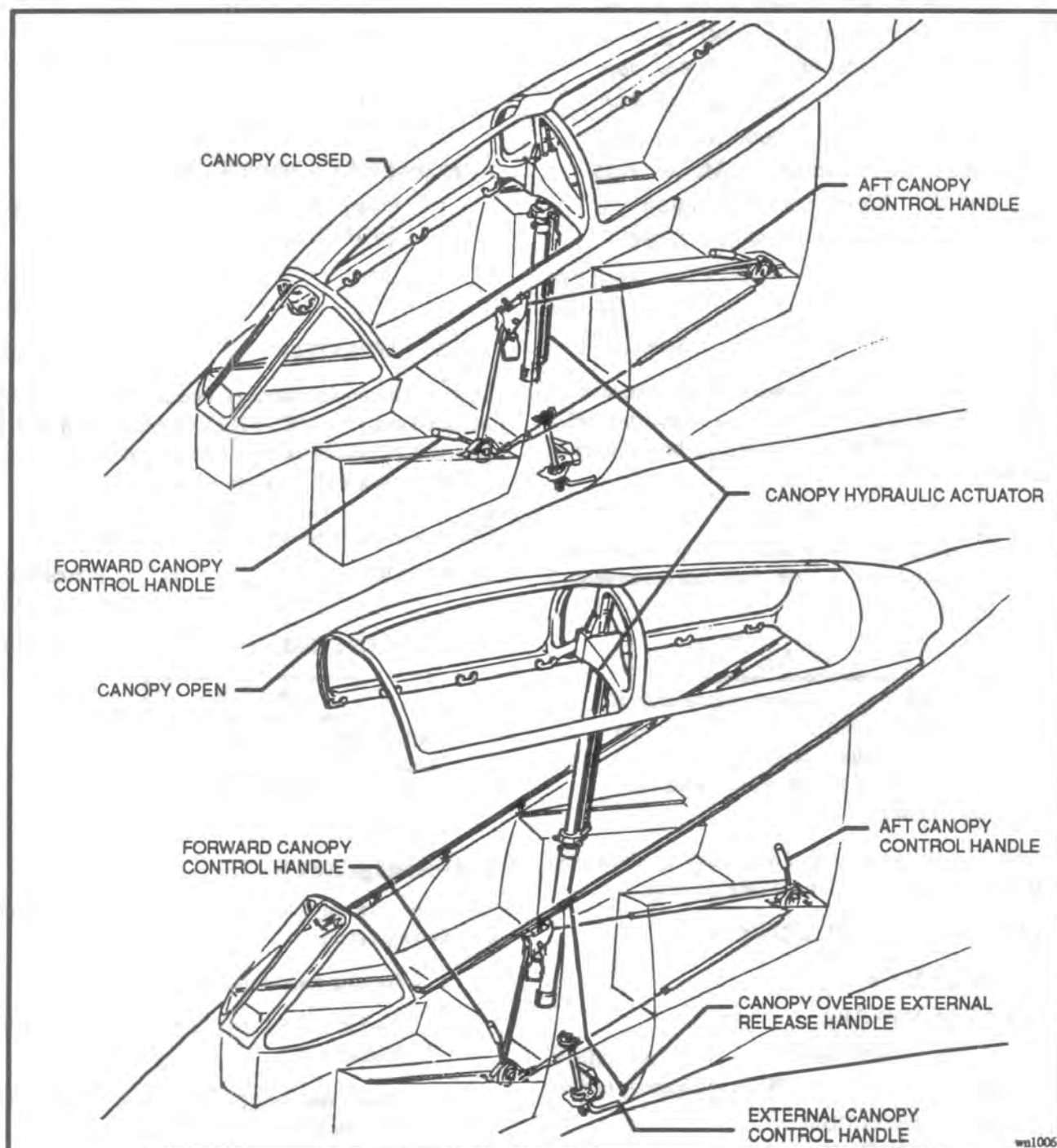


Figure 1-32 Canopy Control System - Normal Operation

WARNING

Prior to opening or closing the canopy a positive ICS check is to be made between pilots, stating "CANOPY OPENING / CLOSING."

CAUTION

Prior to opening or closing the canopy, both pilots must ensure that all canopy contact areas are clear and that all loose gear has been stowed to preclude damage from foreign objects.

Internal Canopy Controls

1.260 Refer Figure 1-32. Canopy controls consist of two interconnected canopy control handles, mechanically linked to the canopy operating mechanism, and a canopy override lock handle (rifle bolt) that locks the canopy in the down position. A hand pump, located adjacent to the fwd R.H console, is attached to hydraulic pumps that provide pressure to actuate the canopy when utility system pressure is not available. A small reservoir replenished from the utility hydraulic system provides sufficient fluid for one operation of the canopy actuator. Approximately 50 strokes of the hand pump are required to open the canopy. The canopy control handle must be used in conjunction with the hand pump in the same manner as with the utility hydraulic system.

1.261 Each control handle is spring locked into a detent in each of two positions, **LOCKED** or **UNLOCKED**. With the handle in the **UNLOCKED** position, forward or rearward movement of the handle controls hydraulic pressure to close or open the canopy. The speed of canopy

movement varies with the amount of handle movement. An interlock prevents the handle from being moved to **LOCKED** until the canopy is fully closed. The canopy is mechanically stopped at approximately 8 inches open by the safety stop and must be raised approximately 2 inches before it can be lowered to fully closed. As the handle is moved to **LOCKED**, the latch hooks engage to hold the canopy in place and the canopy seal is inflated.

CAUTION

If the control handle load does not drop off as the handle is moved to **LOCKED**, canopy rigging must be checked prior to flight.

1.262 The rifle bolt locking mechanism, located along the left hand cockpit rail, ensures that the normal canopy locking system is secured in the closed and locked position. The canopy warning light will illuminate any time the canopy is not closed and locked and the rifle bolt is in the closed position.

CAUTION

Unless the canopy rifle bolt is in the forward, closed position, and the canopy warning light is out, the canopy is not secured, and may be lost as airspeed increases to approximately 240 KIAS. In this situation, depressing the canopy control handle will apply normal utility hydraulic pressure to the canopy actuating system but will not ensure that the canopy will remain with the aircraft.

Airspeed must be decreased until the canopy can be locked or a landing can be made.

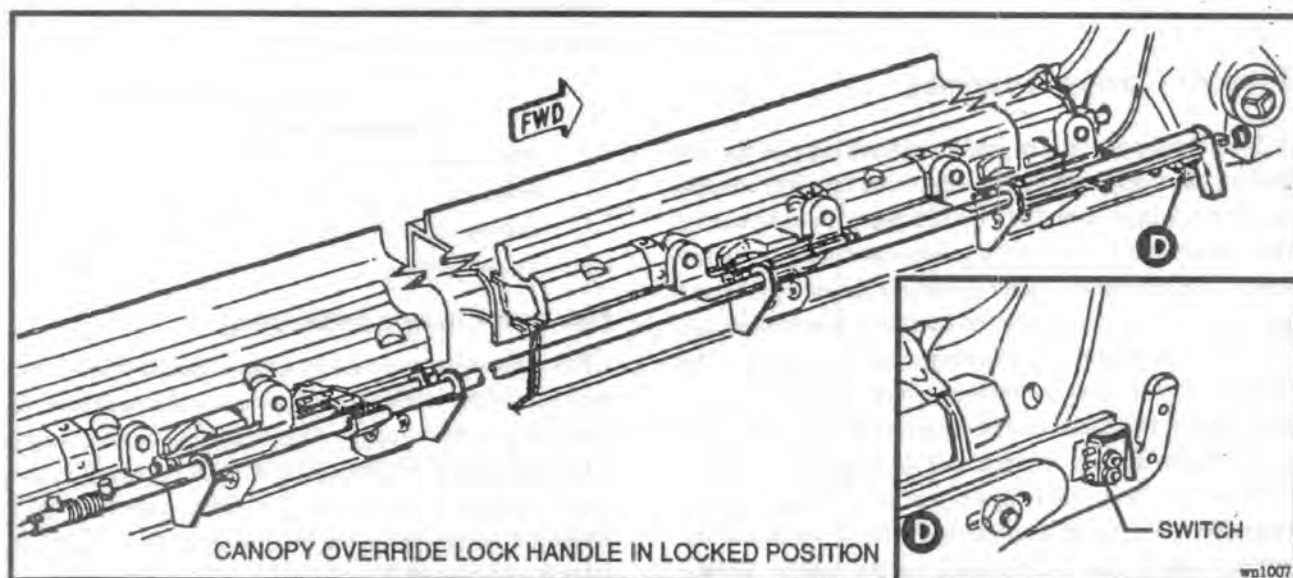


Figure 1-33 Canopy Unlock Warning Light Assemblies

AL 5(0)

External Canopy Control Handle

1.263 Located fwd of the wing behind the L.H. external access door are:

- The external canopy control handle.
- Canopy override external release handle.
- Canopy hydraulic hand pump.

1.264 They are mechanically connected to the internal canopy control handles. To unlock the canopy when the rifle bolt is engaged:

- The canopy override release handle must be pulled and held fully down.
- The canopy external control handle engaged and moved outwards to the unlock position.

NOTE

The single act of pulling the canopy override external release handle will not unlock the override lock.

1.265 The action of moving the canopy control handle outboard or inboard raises or lowers the canopy. The external canopy control handle may be used with either hand pump hydraulic pressure or utility hydraulic system pressure.

Internal Canopy Jettisoning

1.266 The canopy may be jettisoned from any position, by pulling the canopy jettison handle above the right console in either cockpit. A pull of 20 to 35 pounds on the handle fires an initiator, which causes canopy latch thrusters to fire and unlock the canopy. After unlocking the canopy, excess gas from the thrusters fires the canopy remover cartridge which is located within the canopy actuator assembly. The remover forces open the canopy which rotates about the hinge points to jettison free of the aircraft. The handle will move approximately $\frac{1}{2}$ inch and then fall free after the cartridge has been fired. To prevent the canopy remover cartridge from being inadvertently fired while on the ground, safety pins are provided for the canopy jettison system and are connected by a red streamer stencilled "REMOVE BEFORE FLIGHT."

WARNING

The canopy control handles will snap rearward as the canopy is jettisoned. Keep hand and arm clear of this area to avoid possible injury.

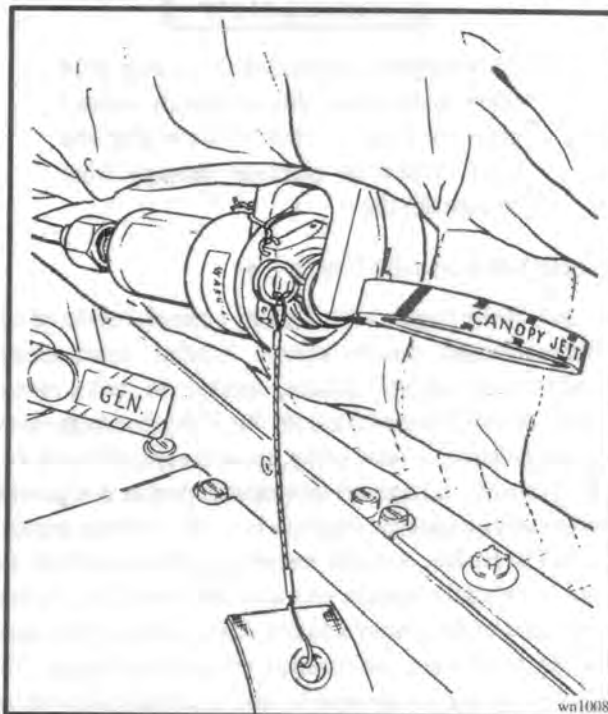


Figure 1-34 Canopy Jettison Initiator (M99)

1.267 If the canopy fails to jettison ballistically it must be aerodynamically removed. Normally, with airspeed above 120 knots, the canopy can be removed by unlocking the rifle bolt and moving the canopy control handle to the **OPEN** position. If the canopy will not raise and is not jettisoned by this means, an increase in airspeed to 240 knots will be required to accomplish jettison.

NOTE

The canopy control handle will not snap rearward if the canopy is jettisoned aerodynamically by use of the canopy control handle.

External Canopy Jettisoning

1.268 An emergency canopy jettison handle is located on each side of the fuselage, just forward of the wing root, for jettisoning of the canopy during rescue. The control handle, marked **PULL CANOPY JETTISON**, is installed in a recess behind a spring loaded door, indicated by a **RESCUE** arrow. When the door is pushed in, the handle extends and may be grasped and pulled to fire the canopy actuator cartridge. The canopy will jettison regardless of position.

Underwater Canopy Jettison Relief Valve

1.269 The aircraft is equipped with an underwater canopy jettison relief valve which will allow water to flow into the cockpit after ditching. The relief valve is located on the cockpit floor below the canopy actuator cylinder. The underwater canopy jettison relief valve is a panel that is designed to open when the outside water pressure head is approximately 2 psi. The flow of water into the cockpit reduces the effective pressure head on the canopy. The use of the canopy jettison handle for quick exit from the cockpit is recommended in order to utilize the power of the canopy remover. The use of the canopy control handle and hand operated hydraulic pump should be considered as a last resort method of underwater canopy opening.

A-4 CANOPY

1.270 The cockpit canopy, shown in Figure 1-35, is hinged at the rear and moves back and up when opened. When closed, the canopy is held in place on both sides of the canopy rail by latch hooks which engage fixed rollers on the cockpit rails. An air bungee cylinder, mounted

behind the ejection seat, counterbalances the canopy during normal operation and provides snubbing action. Low pressure of the canopy bungee system does not jeopardize canopy jettison capability.

Canopy Restraint Strap

1.271 A canopy restraint strap is used to prevent damage to the canopy hinges and bungee piston due to hammering which occurs when the aircraft is taxied with the canopy open. The strap is attached to the inside of the cockpit coaming at the forward edge of the map case. When the restraint strap loop is attached to the right hand canopy latching hook, the canopy is held just short of the open position. The restraint strap must be disengaged from the canopy latching hook and stowed in the pouch prior to closing and locking canopy

CAUTION

Normal ejection may be hampered by the canopy restraint strap. No tests have been made of canopy jettisoning with restraint strap attached.

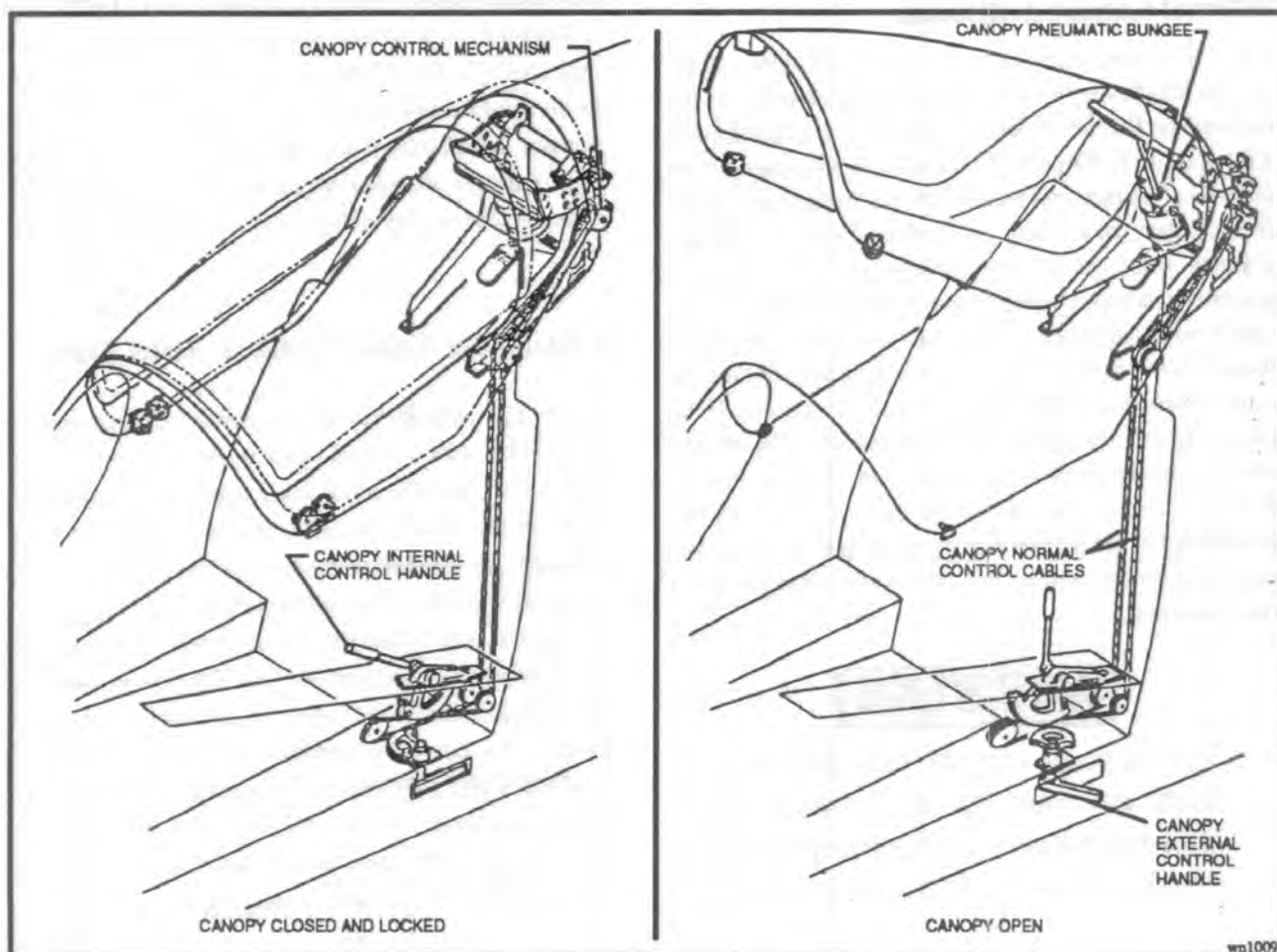


Figure 1-35 Canopy Control System - Normal Operation

AL 5(0)

Operation

1.272 The canopy lever on the left console, is mechanically linked to the canopy mechanism. The canopy is closed by grasping the ledge on either side and by pulling down, overriding the air bungee cylinder pressure. Moving the lever forward slides the canopy forward, causing the latch hooks to engage the latch rollers. Moving the lever rearward causes the canopy to move back, disengaging the latch hooks and allowing air bungee pressure to open the canopy. The canopy mechanism includes an overcentre position to the locked position. If the lever load does not drop off as the handle is moved overcentre, canopy rigging should be checked.

External Canopy Release Handle

1.273 An external canopy release handle is set flush in the left side of the fuselage below the cockpit. Pulling the external canopy release handle out and forward unlatches the canopy, allowing it to open in the normal manner. To be closed and locked from the outside the canopy must be manually held down and the external handle pushed in until it is flush with the fuselage.

Internal Canopy Jettisoning

1.274 The canopy may be jettisoned by pulling the canopy jettison handle on the right side above the console. To fire the initiator, the canopy jettison handle must be pulled with a force of 20 to 35 pounds. The handle will extend three quarters of an inch and then fall free after the initiator has fired. When the canopy jettison handle is pulled, gas pressure from the Mk 99 initiator forces a piston to puncture the canopy pneumatic bungee nitrogen bottle. Compressed nitrogen is released into the pneumatic bungee, forcing the bungee downward initially, pulling the canopy back to unlatch. Remaining nitrogen gasses in the bungee propel the bungee piston upwards. The canopy swings rapidly open and shears at the hinges. At an airspeed of 125 knots or above, the canopy will shear when it is opened by the normal canopy opening lever. However, use of the canopy jettison handle to jettison the canopy is recommended.

WARNING

The canopy control handle/s will snap rearward as the canopy is jettisoned. Keep hand and arm clear of this area to avoid possible injury.

1.275 When canopy is jettisoned in flight by any means, rapid rearward movement of manual canopy lever occurs as wind raises and shears canopy. To avoid possible injury, ensure that hands and arms are clear of this area during canopy jettison.

Canopy Jettison Safety Pins

1.276 To prevent the cockpit enclosure air bungee from being inadvertently fired while on the ground, safety pins are provided for the canopy jettison initiators and are connected by a red streamer stencilled "**REMOVE BEFORE FLIGHT**".

External Canopy Jettisoning

1.277 An emergency canopy jettison handle is provided on each side of the fuselage, just forward of the wing root, for jettisoning the canopy during rescue. The control is a red handle, marked "**PULL CANOPY JETTISON**", and is installed in a recess behind a spring loaded door, indicated by a **RESCUE** arrow. When the door is pushed in, the handle extends and may be grasped and pulled to fire initiator, which in turn activates a nitrogen bottle causing high pressure nitrogen to escape into the air bungee cylinder. The canopy will jettison regardless of position.

Underwater Canopy Jettison Relief Valve

1.278 The aircraft has an underwater canopy jettison relief valve which allows water to flow into the cockpit after a ditching. The relief valve installation is a circular insert in the outer skin on the left side of the fuselage, alongside the ejection seat just under the canopy rail. The relief valve is a door, normally sealed and held in place by a torsion rod, and is designed to open when outside water pressure head is approximately 2 psi. The flow of water into the cockpit reduces the effective pressure head on the canopy. To open the canopy underwater, use of the **CANOPY JETTISON** handle is recommended, as it will provide maximum power at the bungee. The use of the manual **CANOPY** lever should be considered as a last resort method of underwater canopy opening.

AL 5(0)

EJECTION SEAT

INTRODUCTION

1.279 The ESCAPAC 1G-3 ejection seat is a ballistic catapult/rocket system that provides the pilot with a quick, safe and positive means of escape from the aircraft under zero speed and zero altitude conditions (with the exception of unusual conditions e.g. high rate of descent, or angle of bank at low altitude). The seat includes an initiation system activated by either the upper or lower ejection handle, which, after jettisoning the canopy and positioning the occupant for ejection, allows the seat rocket motor to fire.

1.280 At initiation of the ejection sequence the canopy is jettisoned and the inertia reel power retract mechanism is fired, pulling the pilot to the proper sitting position. As the canopy clears the aircraft the canopy seat interlock lanyard is withdrawn from the initiator mechanism, unlocking it, and allowing continued pull on the ejection control handle. The Mk 16 rocket catapult is then fired and the seat begins its travel up the guide rails. The emergency oxygen and AN/URT-33 emergency beacon systems are activated by cable lanyards attached to the floor. The anti-G and oxygen hoses are disconnected from the aircraft.

NOTE

In the TA-4, the rear seat is always ejected first, regardless of the position of the headknocker.

1.281 The rocket catapult accelerates the seat from the aircraft and the DART stabilisation system corrects for adverse pitch and roll of the seat on exit. The harness release actuator unlocks the shoulder harness, releases the face curtain, lower ejection handle and RSSK-8 survival kit from the seat and fires the man/seat separator rocket, ensuring positive seat separation 0.55 seconds after the start of the initial ejection sequence. As the rocket forces the seat away from the pilot, the parachute actuator arming lanyard is pulled which arms the barometric time delay parachute actuator and the external pilot chute (EPC) is deployed. An automatic time release mechanism, after a delay of 0.75 seconds, opens the main parachute container and releases the drogue chutes to deploy the main parachute when altitude conditions are met. The time release mechanism does not actuate until the seat is below $14,000 \pm 500$ feet barometric altitude.

1.282 An NES-12 semi-rigid contoured parachute pack contains the 28 foot flat steerable circular canopy, barometric release actuator, tri stage external pilot chute, internal pilot chute and a ballistic spreader gun. As the main canopy is deployed, the cartridge within the ballistic spreading gun is fired by a static line just prior to line stretch. The resulting gas pressure propels slugs, that are attached to the skirt hem/suspension line junctions, outward to produce uniform, accelerated inflation of the canopy.

WARNING

The pilot should check to ensure that the ballistic spreader gun safety pin is stowed in the safety pin pennant (red) on the forward side of the upper left hand parachute pack opening band. If the ballistic spreader gun safety pin has not been removed, the main canopy will not deploy.

Seat Adjustment

1.283 A three position spring loaded switch located on the rear right hand wedge panel controls the electrically powered seat adjustment.

WARNING

The ejection seat has mechanical stops incorporated to preclude raising the seat beyond the ejection initiation position. No electrical stops exist. If the seat cannot be lowered after hitting the upper stop it should be assumed that the rivets are sheared and ejection is impossible.

AL 5(0)

Shoulder Harness Inertia Reel

1.284 Pilot shoulder harness restraint is provided by an inertia reel mounted in the seat that locks automatically if the aircraft is subjected to a deceleration in excess of 2.5 ± 0.5 G along the thrust line. Manual locking of the reel is controlled by the shoulder harness lock/unlock handle on the left side of the seat bucket.

- a. **LOCKED** – The inertia reel prevents the shoulder straps from being extended forward and ratchets any slack in the straps, back into the reel.
- b. **UNLOCKED** – The reel allows the pilot to lean forward, but the inertia portion of the reel (rearward) continues to protect him by locking the reel when excessive retardation is sensed.

1.285 During ejection the shoulder harness is automatically retracted to position the seat occupant for ejection.

Survival Pack

1.286 Provisions for survival after ejection or ditching are stored in the RSSK-8 survival pack. The pack is composed of a two piece fibreglass container. The lower portion of the pack contains emergency provisions, AN/URT-33 emergency beacon, and an inflatable raft. The upper portion of the pack, containing an emergency oxygen supply, serves as the cover and has a seat cushion attached to the top.

1.287 Manual selection of emergency oxygen is available using a green pull ring on the left forward part of the upper pack, which sits under the inside left thigh. Once initiated the oxygen is supplied through a flexible hose which connects directly to the pilots oxygen mask.

1.288 Two adjustable lap straps are installed on the sides of the pack. These straps connect to a quick release fitting on the pilot's lower torso harness to secure the pilot to the pack which is locked into the seat bucket by the harness release system. The pack can be deployed during parachute descent by pulling the the two survival release handles on the right side of the pack. This unlocks the pack allowing the lower half to fall away while remaining attached to the upper half by a dropline. The life-raft, also attached to the

dropline, falls away by gravity, activating a CO₂ bottle which inflates the raft. An equipment bag containing the other survival aids falls away but remains attached to the upper pack lid by a lanyard.

1.289 Should the pilot land in water before deploying the survival pack, the life-raft can be inflated by pulling the survival pack release handle, and then reaching into the pack and pulling the actuating cable on the life-raft CO₂ bottle.

Harness Release Handle

1.290 The harness release handle labelled **HARNES RELEASE**, is mounted on the right side of the seat. A spring loaded latch, which is grasped with the harness release handle, retains the handle in the proper position and must be squeezed before the latter can be pulled. When the handle is pulled up, the automatic actuator arming cable retainer clip, the EPC static line, the shoulder harness and seat belt attachments are released from the seat, allowing the pilot to leave the cockpit with the parachute and RSSK-8 pack still attached to the integrated torso harness.

WARNING

The harness release handle should not be pulled while the aircraft is airborne or until it comes to a complete stop after landing. Pulling the harness release handle releases the shoulder harness and lap belt end fittings, which cannot be reengaged in flight.

Automatic chute deployment will not occur if the pilot manually separates himself from the seat. The EPC is not available, therefore the pilot is not stabilised prior to main chute opening. The parachute rip-cord must be pulled to deploy the main chute.

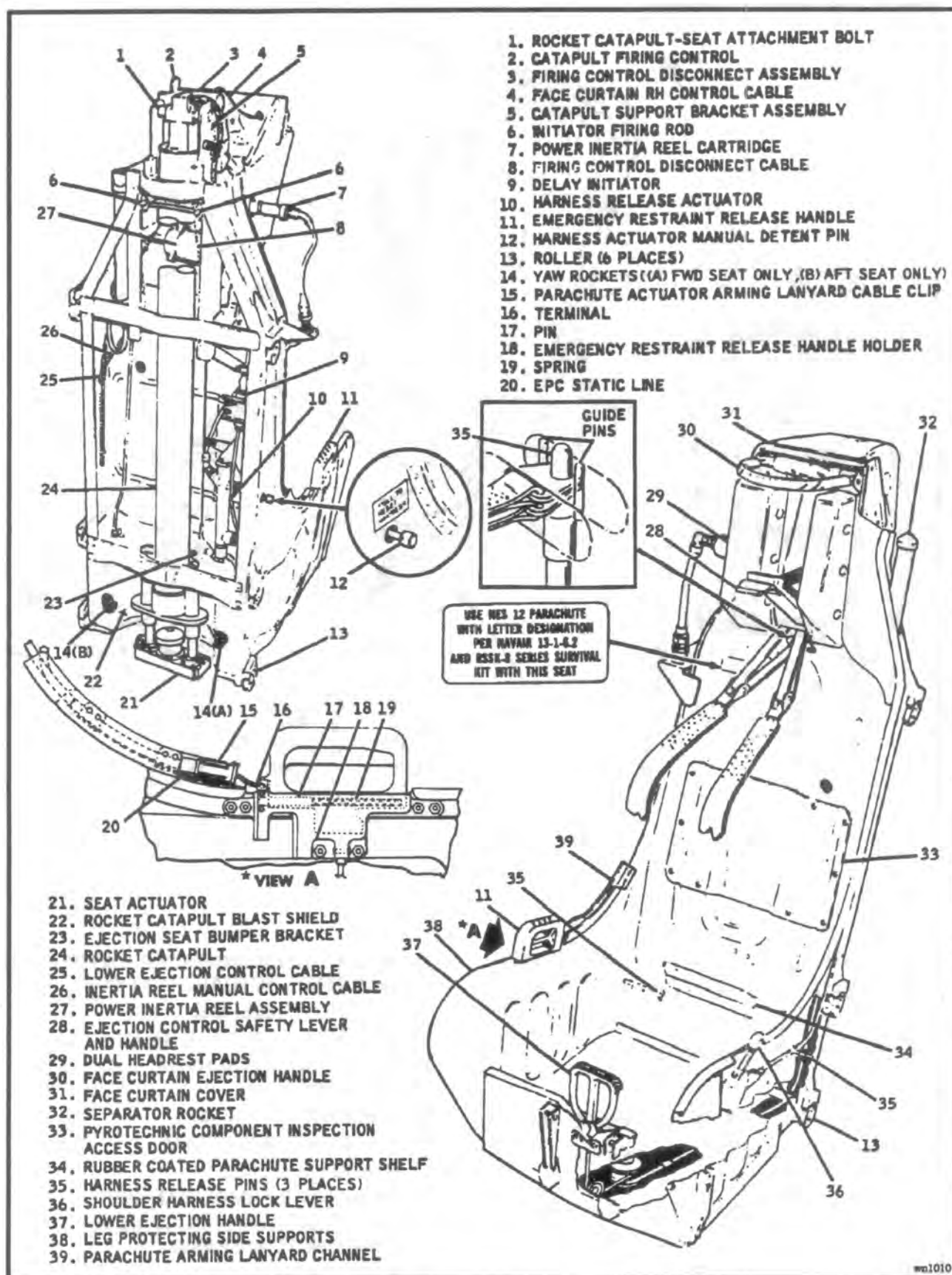


Figure 1-36 ESCAPAC 1G-3 Ejection Seat

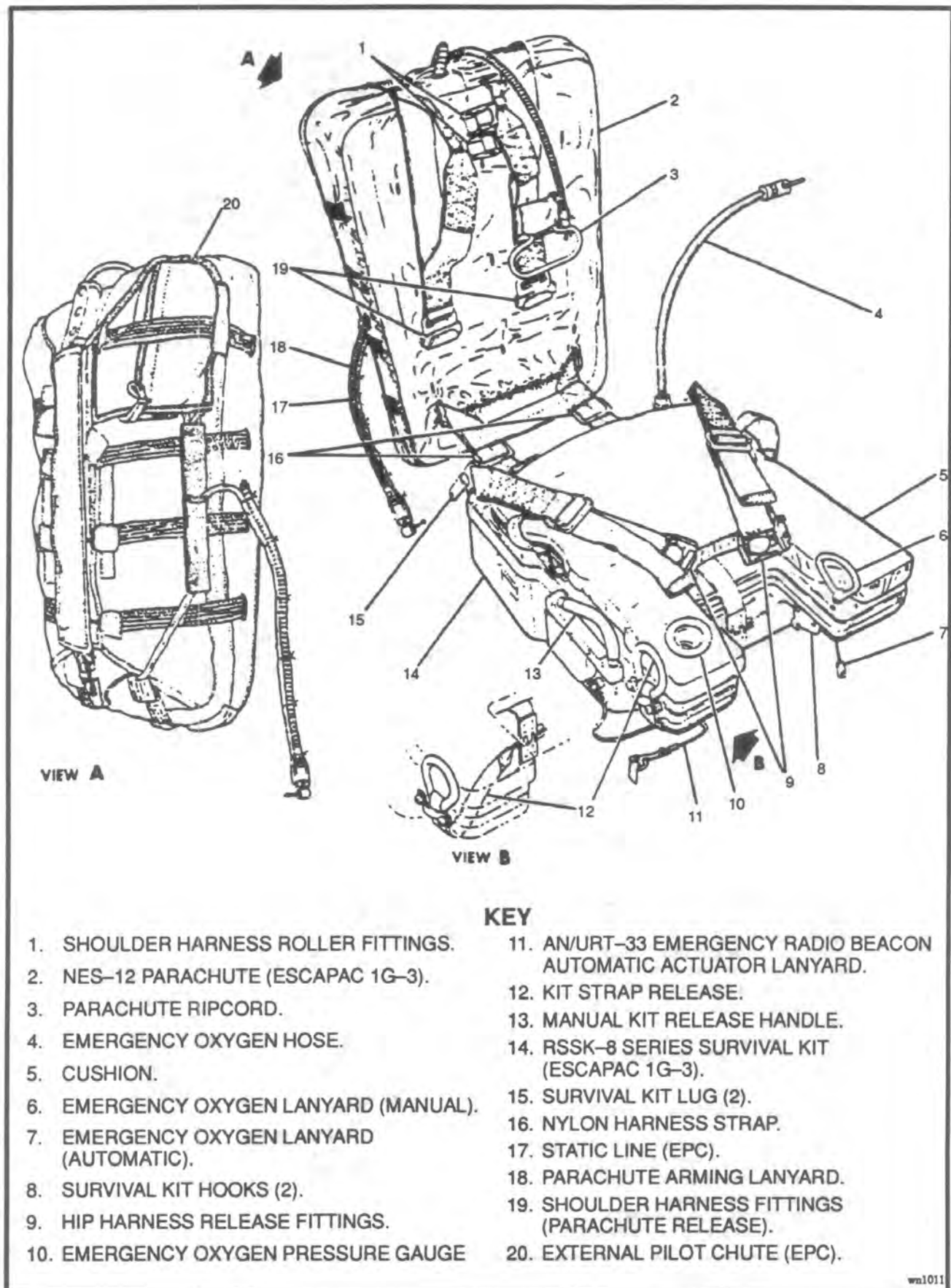


Figure 1-37 Parachute (Typical)

Ejection Control Safety Handle

1.291 The ejection control safety handle (headknocker), located between two rubber pads on the upper forward area of the seat assembly, functions as an ejection seat safety lock when in the **DOWN** position. The headknocker cannot be moved to the **UP** position (unlocking the ejection mechanism) until a safety lock is manually depressed, disengaging the lock.

NOTE

The safety lock is visible only when the headknocker is in the **DOWN** position. The safety lock is identified from above by a black and yellow checkerboard decal, providing visual verification that ejection controls are secured in the locked (headknocker **DOWN**) position.

TA-4 AIRCRAFT ONLY

WARNING

The Headknocker shall not be lowered to preclude an inadvertent ejection as the head/neck would be in a dangerous ejection position if ejection were to be initiated by the other cockpit.

The pilot in command shall ensure that both headknockers are in the same position at all times when both seats are occupied.

Ejection Seat Stabilization System (Dart)

1.292 The ejection seat stabilization system counteracts the adverse effects of aerodynamics and seat system centre of gravity variations. The system provides a consistent and predictable trajectory during the rocket burning phase. The stabilization system is installed on the under side of the seat bucket and consists of two brake units, a deployable bridle arrangement, and four nylon drag lines. As the seat ejects, the slack line stowed in the deployment pouch pays out, and the bridle drops into position. At a preprogrammed distance, the system lines are pulled through the brake units, developing a preprogrammed force in the lines, and consequently, a moment around the systems centre of gravity which counteracts any adverse rotation of the seat.

TA-4 Ejection Seat Control Selector Valve

1.293 A sequencing system is installed to allow dual ejection from either cockpit, or single rear seat ejection initiated from the rear cockpit. The two position ejection seat control selector valve is located in the forward cockpit on the bulkhead behind the left console. Positioning is accomplished by pulling out the locking button and rotating the selector lever to the required position.

- a. **UP** – the pilot in the forward cockpit can eject both seats, while the pilot in the rear cockpit can eject the rear seat only.
- b. **DOWN** – both seats can be ejected, regardless of which pilot initiates the ejection sequence.

1.294 With a command initiation, the system ejects both seats automatically with the rear seat preceding the forward seat by 0.55 second to ensure the rear occupant is not injured from rocket blast.

Ejection Sequence

1.295 Refer to Chapter 5 for ejection sequence and safe ejection envelopes.

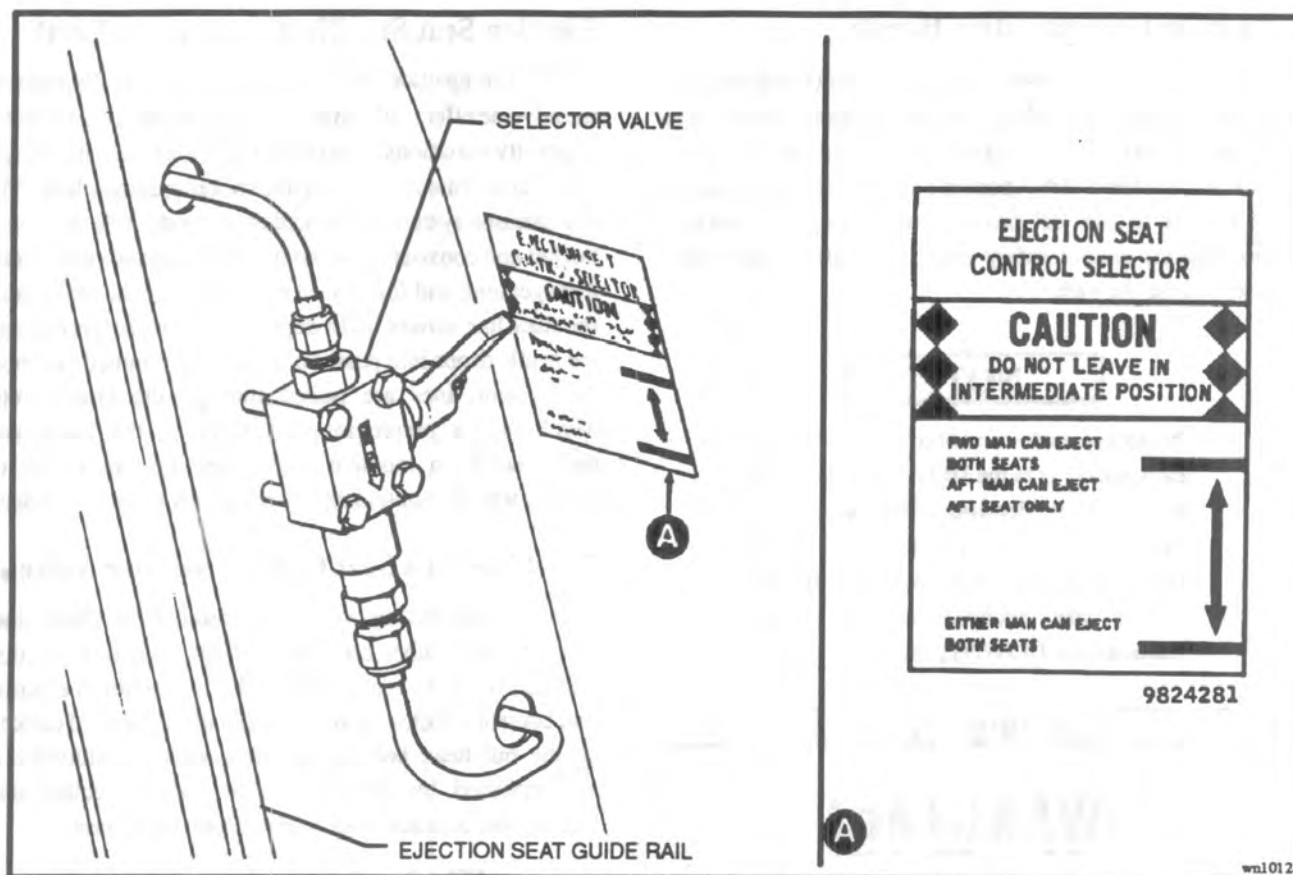


Figure 1-38 Ejection Seat Control Selector Valve

OXYGEN SYSTEM

INTRODUCTION

1.296 Oxygen is supplied by a single 10 litre vacuum bottle liquid oxygen converter mounted in a vented compartment in the rear fuselage section. Evaporation loss is constant when the system is not in use, and this loss is used to pressurize the system. By venting any excess pressure overboard through relief valves, pressure is maintained at 70 ± 5 psi. Venting pressure may increase to 100 ± 10 psi when the liquid oxygen system is not being used.

CONTROLS AND EQUIPMENT

Liquid Oxygen Quantity Indicator

1.297 A liquid oxygen quantity indicator, graduated in litres, is located on the instrument panel. The quantity indicator is electrically operated and has a small OFF window to show that the indicator is inaccurate when electrical power is lost. A red low level warning light on the indicator face will light when the oxygen quantity falls below 1 litre. Depressing the TEST button on the instrument panel tests the operation of the liquid oxygen quantity indicator causing the pointer to move anticlockwise. The low level warning light will come on when the pointer passes the 1 litre mark.

1.298 The liquid oxygen system supplies 100% oxygen in a gaseous state to the regulator(s) in the cockpit(s). When the system is in use, gaseous oxygen flows through a warm up coil to the oxygen regulator ON-OFF valve. The warm up coil ensures complete conversion to a gaseous state and brings the oxygen to a breathable temperature. Oxygen pressure, flow and air to oxygen mixture ratio (dilution) are automatically controlled by the regulator during normal operation. 100% oxygen and Emergency Pressure are manually selectable for emergencies. Also, an emergency oxygen supply bottle is available in the seat, in the event of the main system failing completely or during ejection.

Oxygen Regulator

1.299 The CRU-68A oxygen regulator shown in Figure 1-39 is located in the left hand console and contains a SUPPLY ON-OFF valve, an oxygen diluter lever, EMERGENCY pressure oxygen lever, flow indicator and oxygen pressure indicator. The oxygen regulator schedules the flow and pressure of the oxygen as cabin altitude and pilot demands dictate. The following paragraphs give a brief description of panel switch functions.



Figure 1-39 Oxygen Regulator

1.300 The SUPPLY Valve has two positions:

- a. **ON** – allows gaseous oxygen flow through the regulator to the pilots mask. The switch is normally safety wired to the ON position.
- b. **OFF** – turns the regulator oxygen supply off however, at low altitudes, it may still be possible to breathe cockpit air through the regulator (provided also that emergency pressure is not selected on).

1.301 The OXYGEN Diluter Lever has two positions:

- a. **NORMAL OXYGEN** – Provides a regulated mixture of cockpit air and oxygen determined by cockpit altitude. Above approximately 28,000 ft cabin altitude, 100% oxygen is automatically provided.
- b. **100% OXYGEN** – Provides regulated 100% oxygen supply irrespective of cockpit altitudes.

1.302 The EMERGENCY PRESSURE OXYGEN Lever has three positions.

- a. **NORMAL** – At cockpit altitudes below 27,000 ft, the regulator provides the appropriate breathing mixture (dependant upon oxygen diluter lever position and cockpit altitude) on suction demand. Above 27,000 ft, a small positive safety pressure is automatically provided to reduce the effects of any small leaks in the pilots oxygen hose and mask. Above 38,000 ft and up to the regulators service ceiling of 50,000 ft, an increasing pressure breathing schedule is automatically provided.
- b. **EMERGENCY** – Selects positive pressure flow of the oxygen mixture, either diluted or 100% as determined by the position of the oxygen diluter lever.
- c. **TEST** – Selects increased positive pressure oxygen flow to test mask and hose for leaks. Oxygen mixture, diluted or 100%, depends upon position of oxygen diluter lever.

1.303 The FLOW "dolls-eye" turns white indicating oxygen/air flow during pilots inhalation and black when the pilot is not breathing in.

1.304 The Oxygen Pressure Indicator indicates gaseous oxygen pressure in psi at the regulator.

Emergency Oxygen Supply

1.305 Emergency oxygen is contained in a U-shaped cylinder installed in the seat pan/survival kit. The cylinder pressure gauge, visible through the upper surface of the forward right corner of the seat pan/survival kit, should register 1800 psi when the cylinder is full. A restrictor allows a constant flow of oxygen at approximately 10-14 litres/min at sea level through the emergency hose to the face mask. The duration of the emergency supply is approximately seven to eight minutes regardless of altitude. If the pilot desires to use the emergency supply, he must pull the manual release handle (green O ring), turn off the normal oxygen supply from the regulator, and disconnect the oxygen mask from the aircraft supply at the quick disconnect. The manual release handle (green O ring) is attached to the actuator assembly and to the cockpit floor through a quick disconnect fitting. When the seat or the

pilot (still attached to his survival kit) is ejected from the cockpit, the lanyard attached to the cockpit floor initiates the flow of emergency oxygen automatically.

NOTE

At sea level the flow is insufficient for normal pilot breathing rates and air must be drawn in through the inlet connector at the bottom of the mask hose. A significant inspiratory resistance will be experienced. At high altitudes however, the flow to the mask increases markedly such that above 20-25,000 ft it may be more than sufficient to meet the pilots breathing demand. In such instances the oxygen will be provided at a pressure limited by the outward relief of the inlet connector (about twice the emergency pressure selectable on the main regulator). At all altitudes exhalation must overcome the pressure of the continually incoming oxygen. A significant expiratory resistance will be experienced.

ENVIRONMENTAL SYSTEMS

AIR CONDITIONING AND PRESSURIZATION

Introduction

1.306 A combination air conditioning and pressurization system heats, cools, ventilates, and pressurizes the cockpit. The system comprises of an air cycle refrigeration unit, a cockpit pressure regulator, pressure relief valves, and temperature control components. A separate identical system is provided for the rear seat of the TA-4. Control panels vary slightly between A-4 and TA-4 as shown in Figure 1-43.

Air Conditioning

1.307 Hot high pressure air is bled from the engine compressor section and is ducted either through or around a refrigeration unit, as governed by a cockpit temperature controller. Air passing through the refrigeration unit is directed through a heat exchanger and turbine, where it is expanded and cooled. The cooled air from the refrigeration unit is further mixed with hot air which has bypassed the unit and is delivered to the cockpit.

1.308 The degree of mixing of the conditioned air is controlled automatically by an air temperature control valve, which maintains the cockpit inlet air at the

temperature selected from the cockpit. The temperature control is functional whenever the cockpit pressurization switch is in the **NORMAL** position. In normal operation, the control is set in the arc (from 10 o'clock to 2 o'clock) between **MAN COLD** and **MAN HOT** to provide the desired cockpit temperature.

1.309 In the event of a malfunction in the normal temperature control circuitry, manual temperature control is provided by rotating the temperature control past a detent to the **MAN COLD** or **MAN HOT** positions. These positions bypass the automatic temperature control circuitry and change the mixing of hot and refrigerated air in the selected direction as long as the control is held in position.

1.310 The temperature control is spring loaded away from the **MAN COLD** and **MAN HOT** positions (7 o'clock and 4 o'clock, respectively) and must be held firmly in the desired position against this spring pressure. The temperature control must be held in either position for at least eight seconds to allow complete repositioning of the temperature control valve. When released from the **MAN COLD** or **MAN HOT** positions the mixing valve motor is de-energized, to hold the selected temperature condition. If the air conditioning unit fails or loses electrical power, the cockpit air temperature control and pressurization valves will remain in the same position.

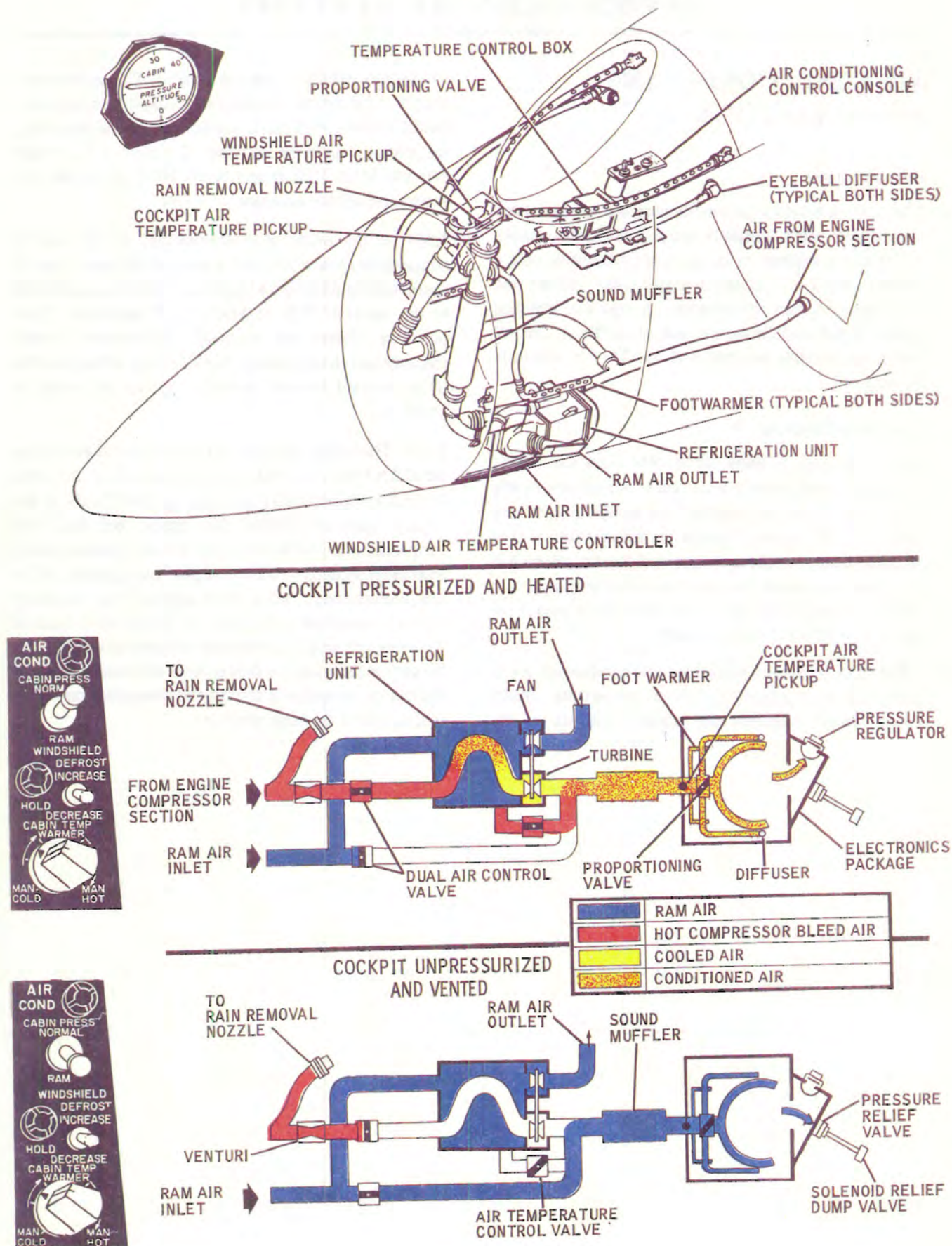


Figure 1-40 A-4 Air Conditioning and Pressurization System

AL 6(0)

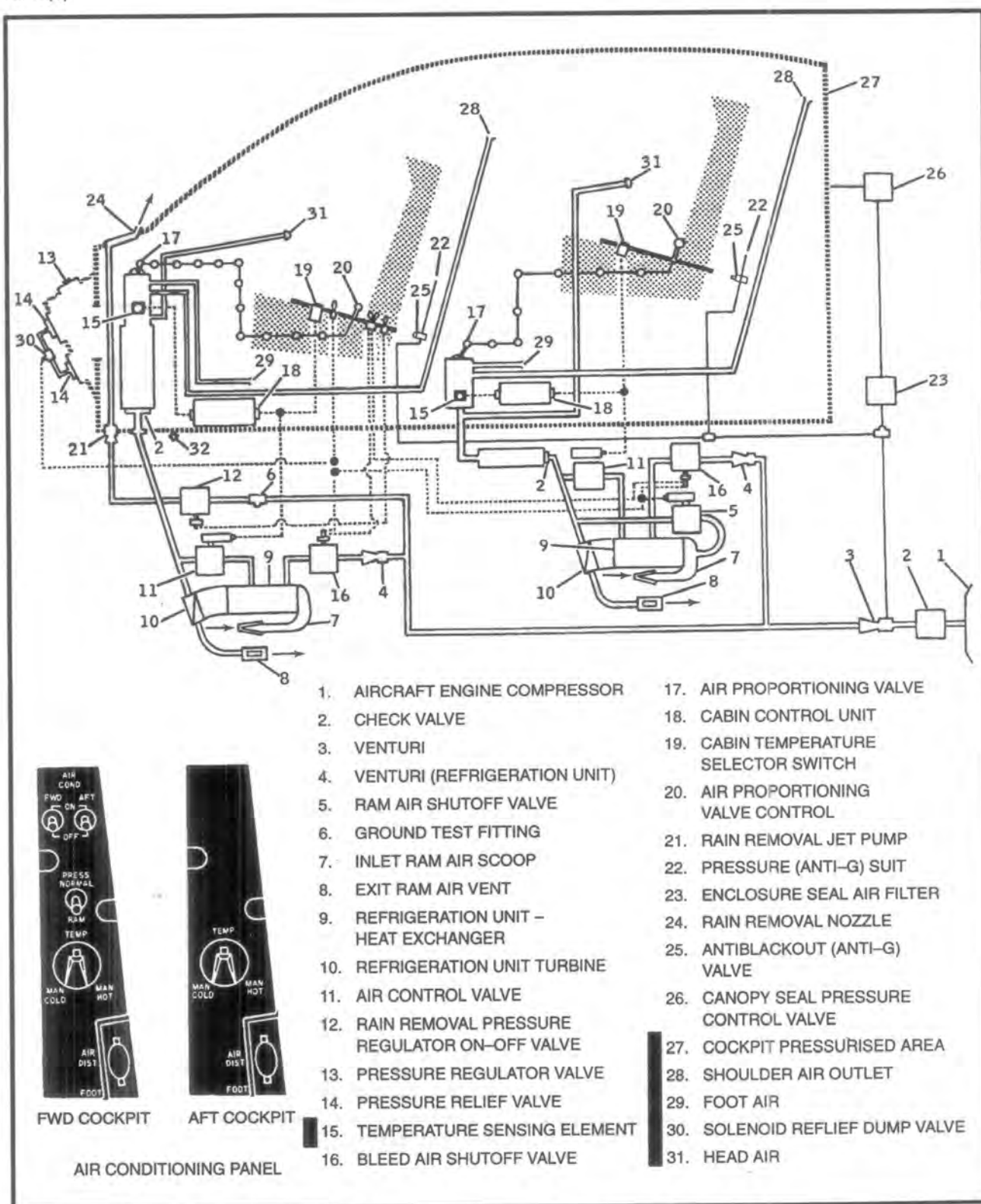


Figure 1-41 TA-4 Air Conditioning and Pressurization System

Pressurization

1.311 When the air conditioning system is in normal operation, the air provided for heating, cooling, and ventilation is also used to pressurize the cockpit. The pressurization schedule provides for cockpit pressure to equal atmospheric pressure from sea level to 8000 feet altitude. The cockpit pressure at 8000 feet is then maintained from an aircraft altitude of 8000 feet to 17,000 feet. Above 17,000 feet, the cockpit pressure is maintained at 3.3 psi above the existing atmospheric pressure. Cockpit pressure is shown in terms of altitude by

the cabin altimeter, located on the instrument panel of each cockpit.

1.312 To prevent excessive positive or negative pressure differentials because of possible malfunctioning of the pressure regulator, a pressure relief valve for each system opens at a positive pressure differential of 3.6 psi and at a negative differential pressure of 0.10 psi. The pressure relief valves incorporate an emergency feature that allows the valves to dump cockpit pressure when the cockpit pressurization switch is placed in the **RAM** position.

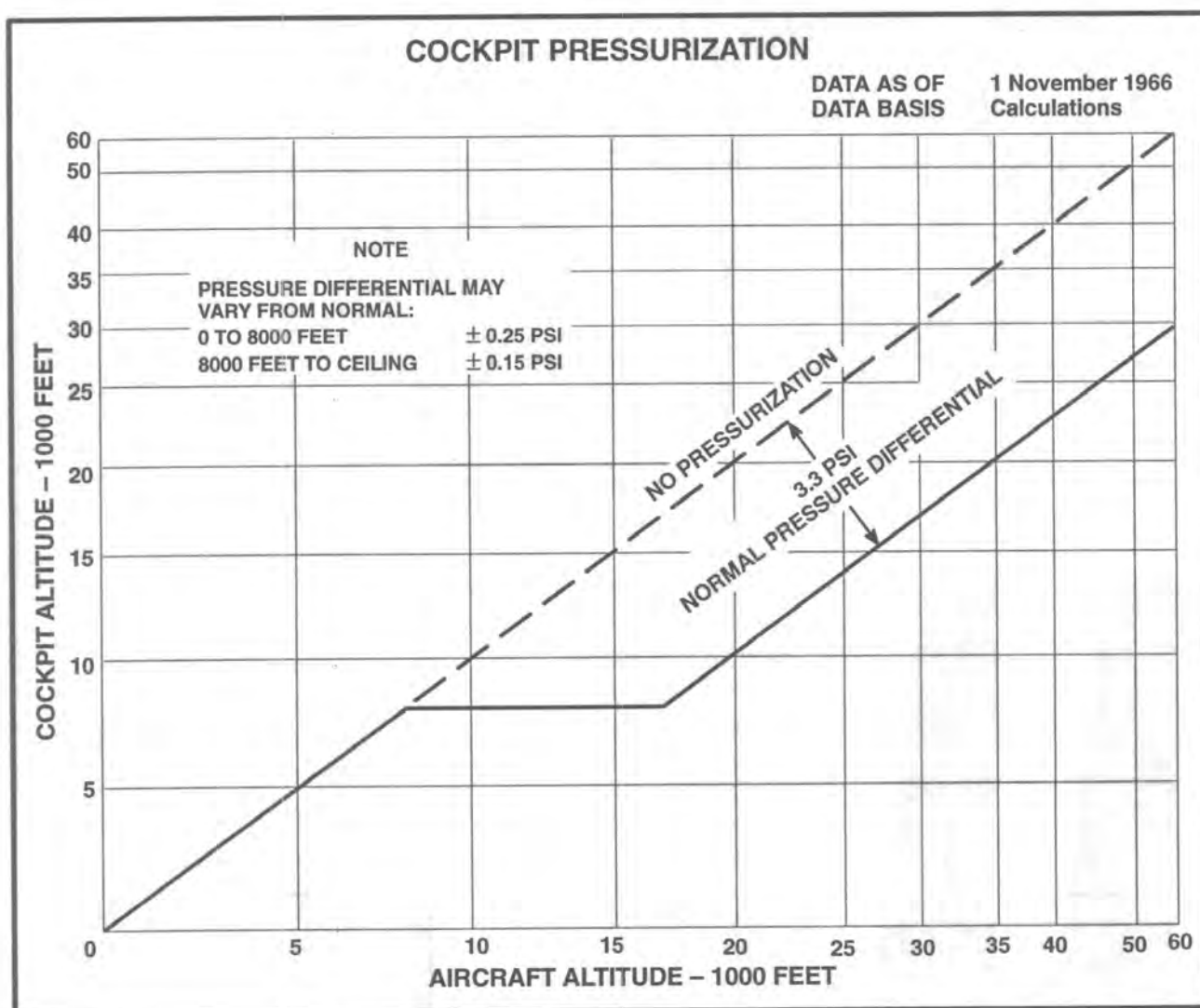


Figure 1-42 Cockpit Pressurization Chart

$$\frac{ALT_{AIR} + 2000}{2} = CABIN ALT$$

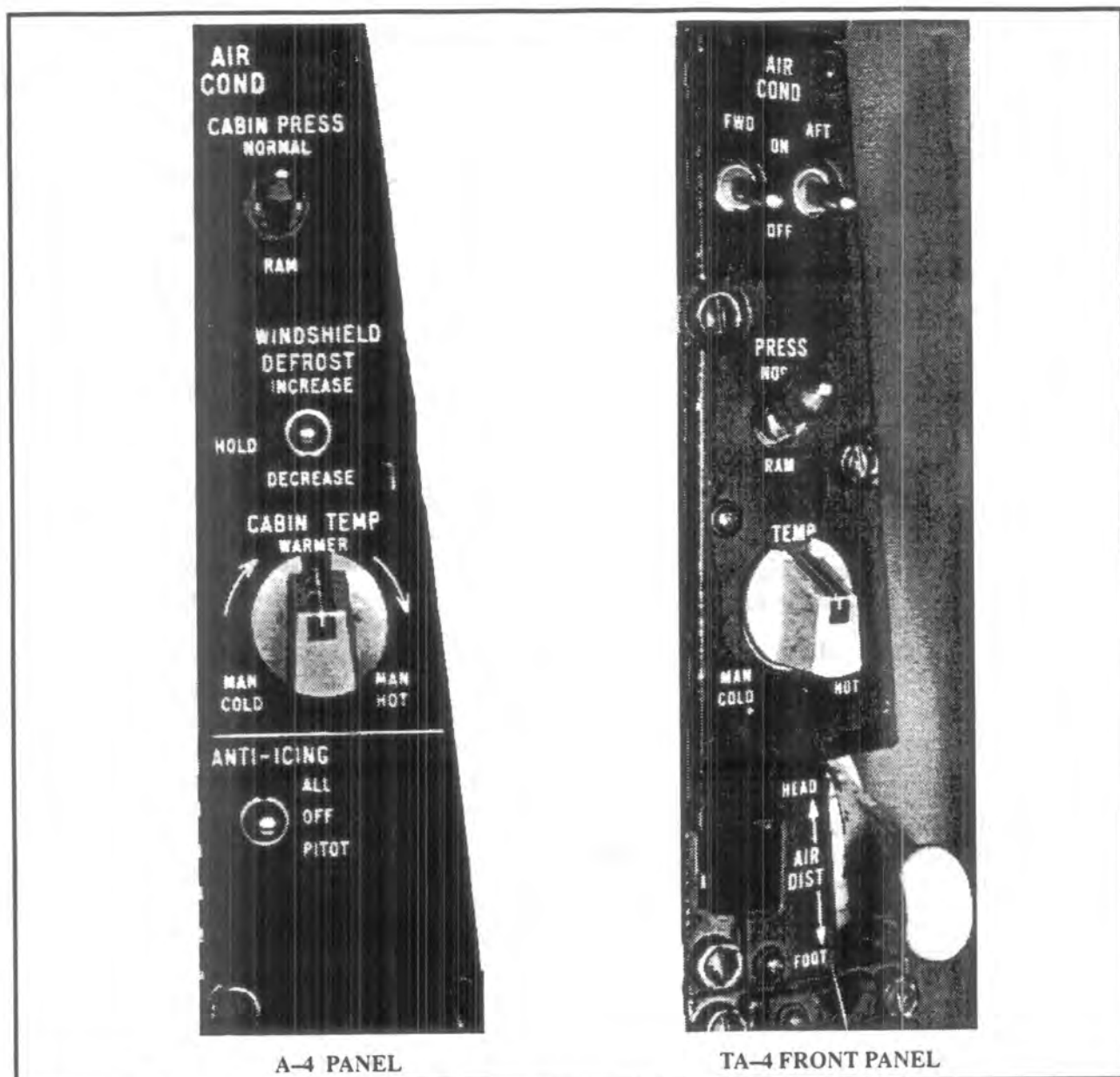


Figure 1-43 A-4 & TA-4 Air-conditioning Wedge Panels

Air Conditioning Control Panels TA-4

1.313 The air conditioning control panel in the forward cockpit is located outboard of the right hand console and is shown in Figure 1-43. It contains two AIR CONDITIONING switches, a PRESSURIZATION switch, TEMPERATURE controller, and the AIR DISTRIBUTION lever. The air conditioning control panel in the rear cockpit is located outboard of the right hand console. The panel contains the rotary CABIN TEMPERATURE control knob and an AIR DISTRIBUTION lever.

1.314 The two AIR COND switches, located on the TA-4 front panel, operate the two refrigeration unit shutoff valves, one for each cockpit:

- a. **OFF** – no conditioned air will enter the cockpit.
- b. **ON** – air will enter the cockpit at temperature selected by the controlling selector switch. The pilot

in the forward cockpit is responsible for the air conditioning, but not the temperature, of both cockpits.

1.315 A two position lever lock toggle switch, labelled CABIN PRESS. (PRESS in TA-4) operates the cabin pressurization system.

- a. **NORMAL** – with the canopy closed, the cockpit is sealed and automatically pressurized at a predetermined schedule by the cockpit pressure regulator.
- b. **RAM** – electrically opens the pressure relief valves to dump cockpit pressure and opens a motor driven valve in the ram air line allowing outside air to ventilate the cockpit. Selecting **RAM** also closes off the engine bleed valve to isolate the air conditioning system.

TA4 - centre only
TA4 - all 3 panels

1.316 The AIR DIST control lever, located in each cockpit has two marked positions: **HEAD** and **FOOT**. The lever operates to divert conditioned air to the position selected by the pilot. To defrost the canopy the air distribution control lever (in both cockpits) must be positioned in the **HEAD** position, the cockpit temperature control knob (in both cockpits) adjusted for a higher temperature, and each eyeball diffuser directed upward toward the opposite side of the canopy. The outlet on diffusers must be rotated to adjust the airflow.

Air Conditioning Control Panel A-4

1.317 The air conditioning control panel is located outboard of the right hand console and is shown in Figure 1-43. It contains a CABIN PRESSURIZATION switch, a rotary CABIN TEMPERATURE control knob, and a three position WINDSHIELD DEFROST switch.

1.318 The two position level lock toggle switch, labelled CABIN PRESS operates the cabin pressurization system.

- a. **NORMAL**—the cockpit is sealed and pressurized by engine compressor bleed air. Pressurization is automatically maintained at a predetermined schedule by the cockpit pressure regulator.
- b. **RAM**—electrically opens a pressure relief valve to dump cockpit pressure and opens a motor driven valve in the ram air duct allowing outside air to ventilate the cockpit. Selecting **RAM** also closes off the supply of engine bleed air to the air conditioning system.

1.319 The three position WINDSHIELD DEFROST switch controls a motor driven proportioning valve which serves to proportion air between the windshield defrost manifold and the footwarmers. Air directed to the footwarmers is also shared with the adjustable eyeball diffusers.

- a. **INCREASE**—operates the proportioning valve which increases the conditioned air flow to the windshield defrosting manifold. If allowed to remain in this position for several seconds, all air entering the cockpit will be directed to the windshield defrost manifold.
- b. **HOLD**—de-energizes the proportioning valve.
- c. **DECREASE**—the proportioning valve decreases the airflow to the windshield and increases the airflow to the footwarmers (and eyeball diffusers if opened) as long as the switch is held in **DECREASE**, or until the proportioning valve reaches its limit. At this time, all air is bypassing the windshield. The switch returns to the **HOLD** position when released.

Windshield Defrost

1.320 Frosting of the bullet resistant glass centre panel of the windshield is prevented by electrical means. This system is energized when the main generator is operating or when external power is supplied. A transparent layer within the glass panel provides resistance for electrical heating, and a sensing element contained in the panel allows the heating controller to automatically regulate the panel temperature. Windshield centre panel defrosting is available on the emergency generator while the Landing Gear is up. The TA-4 windshield side panels are defrosted by electrical resistance heating in a similar manner to the centre panel.

Cockpit Fog And Snow Suppression

1.321 Small quantities of fog, light snow, or ice will frequently appear at the air-conditioning outlets. While this is a normal condition resulting from rapid cooling of air by the air-conditioning unit, an excessively large volume of fog can occur under extreme conditions of high humidity and high ambient air temperatures at low altitude. This fog may be eliminated by adjusting the cabin temperature control knob for a higher cabin temperature, or by directing the flow with the windshield defrost switch away from the windshield ducts. In some instances the ducting may have cooled to a point where fog will persist for a short time after the cockpit temperature has been increased. After the fog has been suppressed, a temperature setting should be selected that will provide the most comfortable temperature above the fogging point.

NOTE

During takeoff in atmospheric conditions of high humidity, difficulty with forward vision can be encountered due to 'fog' coming from the windshield defrost tubes. This can be reduced beforehand by selecting full **DECREASE** and closing the punkah louvers thereby dumping all conditioned air to the footwarmers.

ANTIBLACKOUT SYSTEM

1.322 The antiblackout system utilizes high pressure engine bleed air controlled by a valve located under the anti-G panel on the left hand console in each cockpit. As G forces are increased, the valve will automatically increase the pressure in the suit which is plugged into a receptacle located on the Personal Services Panel (PSP). A push button located at the top of the valve may be manually operated to test the system and to clear it of excessive moisture.

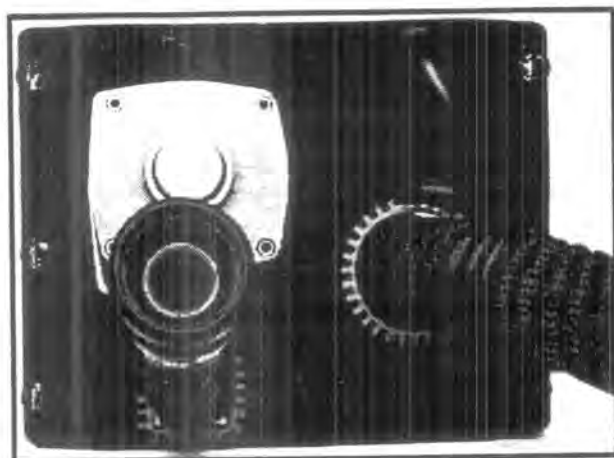


Figure 1-44 Personal Services Panel (PSP)

ENGINE ANTI-ICING SYSTEM

1.323 The engine anti-icing system is designed to prevent ice formation, and safe operation requires that the pilot anticipate the possibility of ice formation whenever icing conditions exist. Ice formation in the engine air inlet section is prevented by an integral power plant system that utilizes hot, high pressure bleed air from the compressor section. Air bled from both sides of the compressor discharge is piped forward through external lines and distributed through the inlet guide vanes from which it is ported into the engine inlet airstream.

1.324 Electrical control of the anti-icing system is accomplished by the three position ANTI-ICING switch, located outboard on the right console.

- a. **ALL** – directs power to the engine anti-icing valve and the pitot tube heating element.

NOTE

Operation below approximately 75 percent RPM may not supply sufficient heat to keep the engine air inlet ducts clear of ice.

- b. **PITOT** – directs power to the electrical heating element in the pitot tube.
- c. **OFF** – Removes electrical power.

ANGLE OF ATTACK SYSTEM HEATING

1.325 The angle-of-attack vane is automatically heated when the aircraft is airborne and is independent of the anti-icing switch. Angle of attack vane heating is not provided when operating on the RAT with gear selected down.

RAIN REMOVAL SYSTEM

1.326 The rain removal system, operated by a switch on the left console, outboard of the throttle, utilizes high pressure engine bleed air to remove rain from the bullet resistant glass centre panel of the windshield. Hot high pressure bleed air is ducted to the rain removal automatic pressure regulating unit. The pressure regulating unit allows constant pressure air to be delivered to the jet pump unit. The jet pump unit mixes the hot bleed air with ambient air and delivers it to a nozzle which directs the high velocity hot air over the windshield surface. In the event of electrical power failure, the valve in the pressure regulating unit automatically closes, shutting off the system. Rain Removal is inoperative on the emergency generator.

Operation

1.327 Rain removal airblast temperatures are a function of engine power setting. At **IDLE** power, airblast temperature is not sufficiently hot to cause damage to the windshield, and the system may be operated continuously. However, at **MILITARY**, the temperature becomes extremely hot, and operation at high power settings is limited to a maximum of 3 minutes.

CAUTION

Exceeding the 3 minute limit could cause bubbling of the vinyl layers and cracking of the glass.

The jet blast rain removal system was designed to operate during conditions of taxi, takeoff, approach, and landing. Operation at conditions other than these is recommended only under extreme emergency flight conditions where forward visibility provided by this system is necessary.

Turning the system on or off at high altitude or cold conditions may cause the outer glass ply of the centre windshield panel to crack due to extreme thermal shock.

Activation of the rain removal system prior to entering precipitation may result in a cracked windshield.

SALT REMOVAL SYSTEM

1.328 The salt removal system, operated by a push button on the left console outboard of the throttle, directs a salt removal fluid onto the centre windshield to wash away salt spray following low altitude over-water operations. The removal fluid is contained in a pressurized bottle within the aircraft nose section.

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AL 10(8)

CHAPTER 2

NORMAL PROCEDURES

	PAGE		PAGE
INTRODUCTION	2-1	AFTER TOUCHDOWN	2-22
PRE FLIGHT	2-1	Normal Braking Technique	2-23
PRIOR TO EXTERNAL INSPECTION	2-1	Minimum Distance, Maximum	
A-4 and TA-4 Front Cockpit	2-1	Braking Technique	2-23
Ejection Seats	2-1	Crosswind Landing	2-23
TA-4 Rear Cockpit	2-5	Landing On A Wet	
EXTERNAL INSPECTION	2-6	Runway/Hydroplaning	2-24
Cockpit Area and Forward Fuselage	2-6	Aerodynamic Braking	2-24
Right-Hand Wheelwell	2-7	Landing On An Ice-covered Runway	2-25
Right-Hand Wing	2-7	Landing at High Gross Weights	2-25
Aft Fuselage and Tail Section	2-8	POST FLIGHT	2-25
Left-Hand Wing	2-8	AFTER LANDING	2-25
Left-Hand Wheelwell	2-8	SHUTDOWN	2-26
Centre Fuselage Underside	2-9	SPECIAL GROUND PROCEDURES	2-27
PRE-START	2-9	Hot Weather Operations	2-27
ENGINE STARTING	2-11	Hero Procedures	2-27
Before Starting The Engine	2-11	Carport Operations	2-27
Starting The Engine	2-11	Engine Oil System	2-27
Pilot-Controlled Starts	2-11	HOT REFUELLING PROCEDURES	2-27
Modified Pilot-Controlled Start	2-11	Prior To Entering the Refuelling Area	2-27
Ground-Controlled Starts	2-11	At The Refuelling Area	2-27
Start Procedure	2-11	During Refuelling	2-28
Engine Starter Cycle Limits	2-12	When Refuelling Complete	2-28
Engine Idle Curves	2-12	Emergency Stop	2-28
Chugs and Stalls	2-12	AIR TO AIR REFUELLING	
AFTER ENGINE START	2-13	PROCEDURES	2-28
Engine Ground Operation	2-13	NORMAL OPERATION	2-28
AIRCRAFT CHECKS	2-14	Before Takeoff	2-28
TAXI	2-15	Drogue Extension	2-29
PRE TAKE OFF	2-16	Engagement And Transfer	2-29
RUNWAY CHECKS	2-16	Stopping Fuel Transfer	2-29
TAKEOFF	2-18	Drogue Retraction	2-29
TAKE-OFF CHECKS	2-19	Transfer From Store To Wing	2-30
AFTER TAKE-OFF	2-19	Dumping Fuel	2-30
Wet Runway Take-Off	2-20	Before Landing	2-30
Minimum Run Take-Off	2-20	JETTISONING THE FUELLING STORE	2-33
Flaps Up Take-Off	2-20	EMERGENCY OPERATION	2-33
IN-FLIGHT	2-21	TANKER SAFETY PRECAUTIONS	2-33
Operating Checks	2-21	STORE LIMITS	2-33
FENCE Checks	2-21	PILOT TECHNIQUE	2-33
Low Flying Checks	2-21	FLIGHT PROCEDURES	
Attack Checks	2-21	REFUELLING TRAINING	2-34
Delivery Checks	2-21	Prior To Refuelling	2-34
Formation Join/AAR Receiver Checks	2-21	Refuelling	2-35
Rejoin Checks	2-21	After Refuelling	2-35
LANDING	2-22	MISSION REFUELLING	2-36
Final Checks	2-22		

CHAPTER 2 Cont. NORMAL PROCEDURES

FIGURES

FIGURE	PAGE	FIGURE	PAGE
2-1	Position Indication Line	2-2	
2-2	A-4 1-G3 Ejection Seat Preflight	2-3	
2-3	TA-4 1-G3 Ejection Seat Preflight	2-4	
2-4	Engine Idle Check Curves	2-12	
		2-5	Estimated N2 Change at 85 Percent N2 at Manual Fuel System Transfer
		2-6	Takeoff Pressure Ratio Chart
		2-7	Tanker Operation — Air Refuelling

AL 8(7)

CHAPTER 2

NORMAL PROCEDURES

INTRODUCTION

2.1 The procedures in this section describe the normal operation of the aircraft. The same information is contained in the Pilots Pocket Checklist (NZAP 6213.005-1CL) in an abbreviated form.

PRE FLIGHT

PRIOR TO EXTERNAL INSPECTION

A-4 and TA-4 Front Cockpit

2.2 The following checks are to be carried out prior to entering the cockpit.

1. Ejection Seat SAFE
2. SVM INSERT
3. DTM INSERT
4. Drag Chute Switch STOW
5. Landing Gear Handle ... LOCKED DOWN

NOTE

This check is to be carried out by physically pushing the handle fully forward and then allowing it to spring back into the solenoid lock.

6. Armament Switches OFF/SAFE
7. CDS OFF
8. Throttle Guard REMOVED
9. External Power ON AFTER RACK
PINS REMOVED

WARNING

Do not remove the rack pins with power applied to the aircraft. Power applied to a rack when removing pins could result in injury to personnel if a fault condition causes immediate jettison of the store.

10. Master Caution CANCEL
11. Landing Gear Indicators INDICATING
DOWN

Ejection Seats

2.3 The following pre-flight checks are to be carried out on the ejection seat prior to flight. (There are differences between the pre-flights for the A-4 to the TA-4.) (Refer Figure 2-1, Figure 2-2 (3 sheets), and Figure 2-3.)

1. Internal Canopy Jettison
System Initiator
(both cockpits) SAFETY PIN
REMOVED
2. Ejection Seat Control Safety
Handle (Headknocker) .. DOWN, SAFETY
PIN REMOVED (TA-4)
3. Initiator Firing Mechanism
(A-4) SAFETY
PIN REMOVED

NOTE

Safety pin will provide the same safety functions whether installed in firing mechanism (A-4) or in the headknocker (TA-4).

4. External Canopy Jettison
System Initiator (A-4) SAFETY PIN
REMOVED
5. Sheepskin cover FIT
6. Canopy Seat Initiator
Safety Pins (TA-4) NOT INSTALLED
7. Canopy Ejection Seat Interlocks
(TA-4) ENSURE SHACKLE
ENGAGES INTERLOCK
HOOK (WITH CANOPY
FULLY OPEN)

AL 8(7)

8. Emergency Oxygen Lanyard CONNECTED
9. Dart System Lanyard CONNECTED
10. Emergency Beacon Lanyard CONNECTED
11. Emergency Oxygen D-Ring STOWED
12. Lower Ejection Handle STOWED
13. Emergency Oxygen Bottle (21°C) . 1800 PSI
14. RSSK 8 Release Handles . STOWED, TIED TOGETHER
15. Emergency Restraint Release Handle/Parachute Arming Cable CONNECTED AND STOWED

WARNING

Ensure parachute arming cable is in retaining clips and cable ball stop is in emergency restraint release handle holder. If the cable and ball are not stowed, automatic parachute deploy will not occur.

16. External Pilot Chute Static Line ROUTED UNDER ARMING CABLE
17. Lap belt and Lap belt Lockpins (2) SECURE
18. Power Inertial Reel Hose Quick Disconnect SECURE
19. Face Curtain STOWED
20. Face Curtain and Lower Ejection Handle Firing Control Cables .. ENGAGED

21. Ejection Seat Firing Control Lever ALIGNED

WARNING

Seat and canopy firing actuator levers should form a Vee approximately 2.5 cm wide when viewed through the perspex housing from the top left side of the seat. A wider or narrower gap may indicate inadvertent actuation of one of the levers.

22. A-4 Canopy Bungee Pressure .. IN LIMITS
23. Canopy Seat Interlock Cable (A-4 only) CONNECTED
24. Man/Seat Separator Rocket SECURE
25. Delay Initiator Quick Disconnect SECURE
26. Shoulder Harness Interia Reel . OPERABLE
27. Shoulder Harness and Lockpin ... SECURE
28. Ballistic Spreader Gun Safety Pin STOWED

WARNING

If ballistic spreader gun safety pin has not been removed, main parachute canopy will not deploy.

29. Parachute Pack CLOSED/CONDITION
30. Ejection Seat Control Selector Lever (Chicken Switch, TA-4 only) AS DESIRED

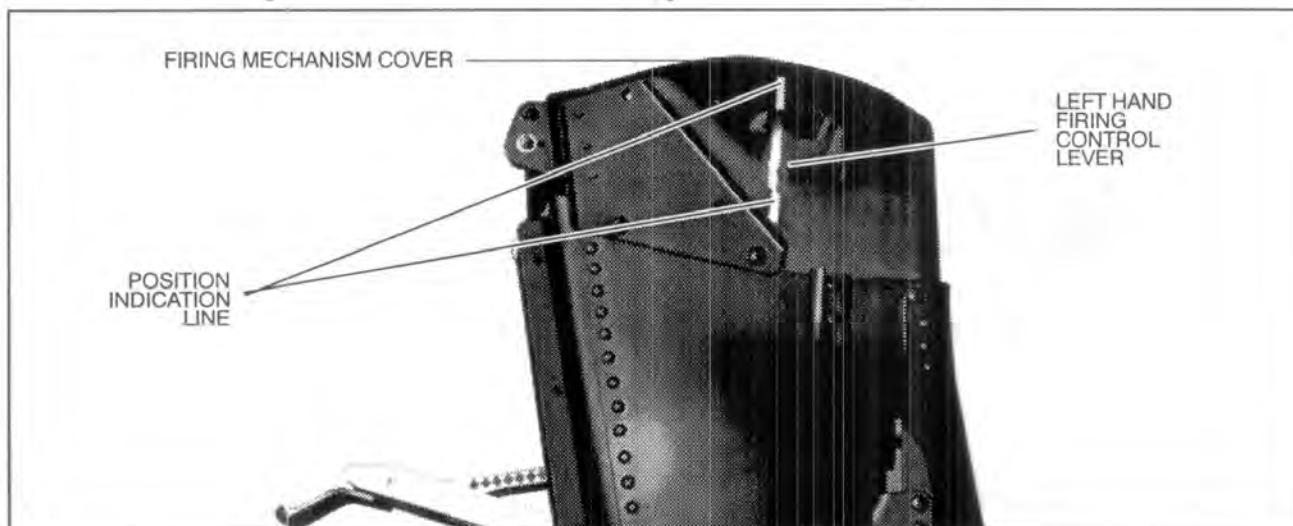


Figure 2-1 Position Indication Line

AL 8(0)

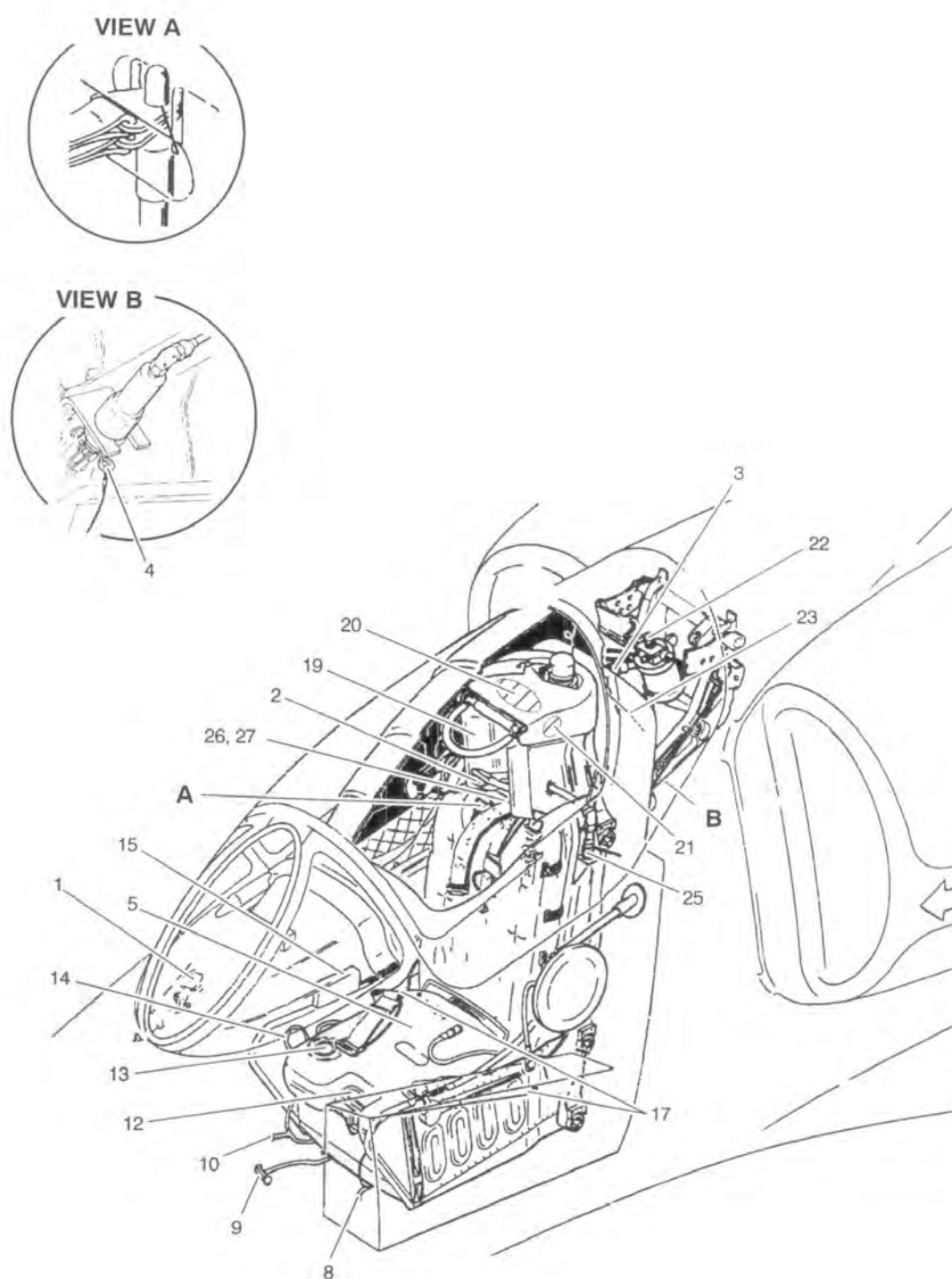


Figure 2-2 A-4 1-G3 Ejection Seat Preflight (Sheet 1 of 3)

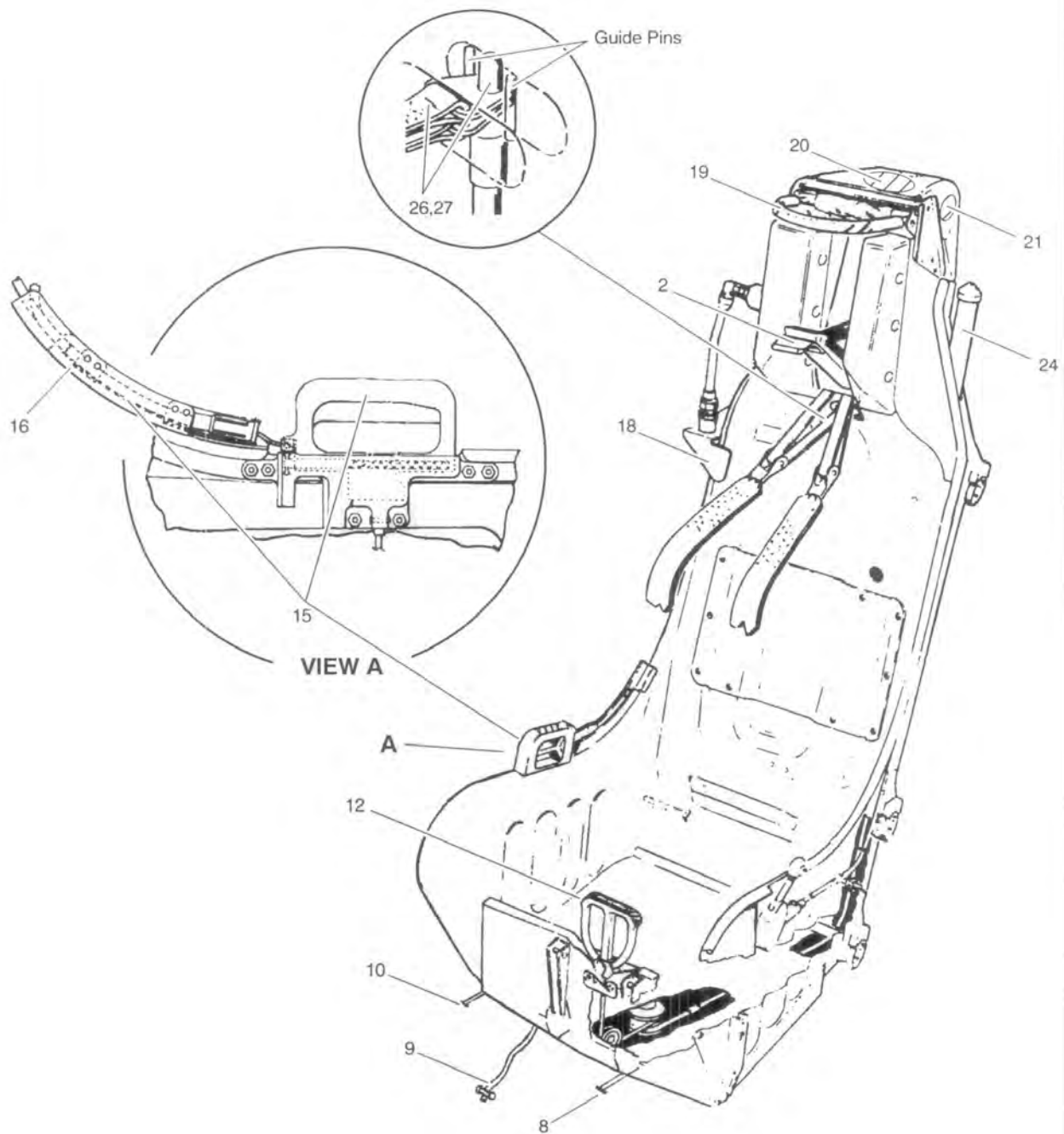


Figure 2-2 A-4 1-G3 Ejection Seat Preflight (Sheet 2 of 3)

AL 8

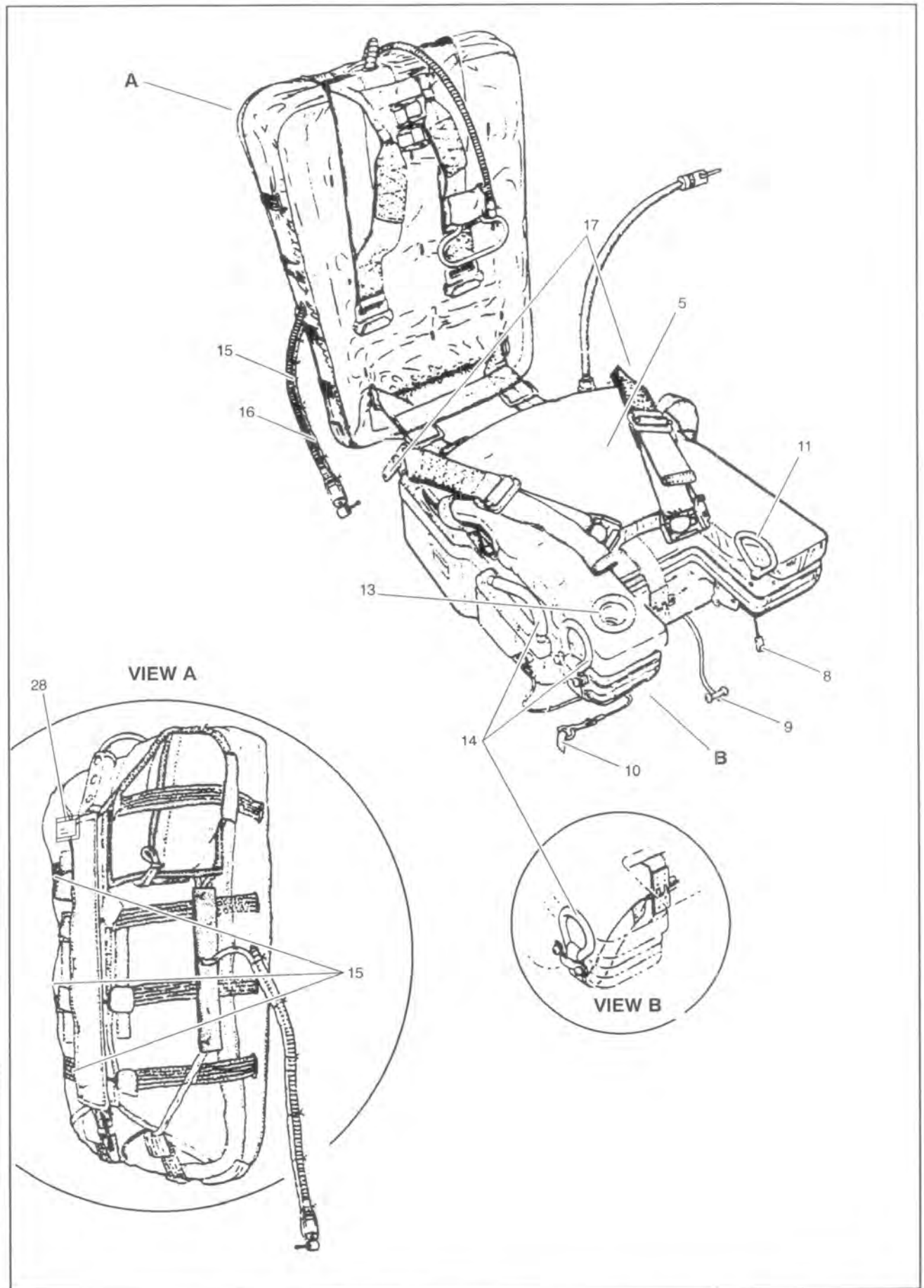


Figure 2-2 A-4 1-G3 Ejection Seat Preflight (Sheet 3 of 3)

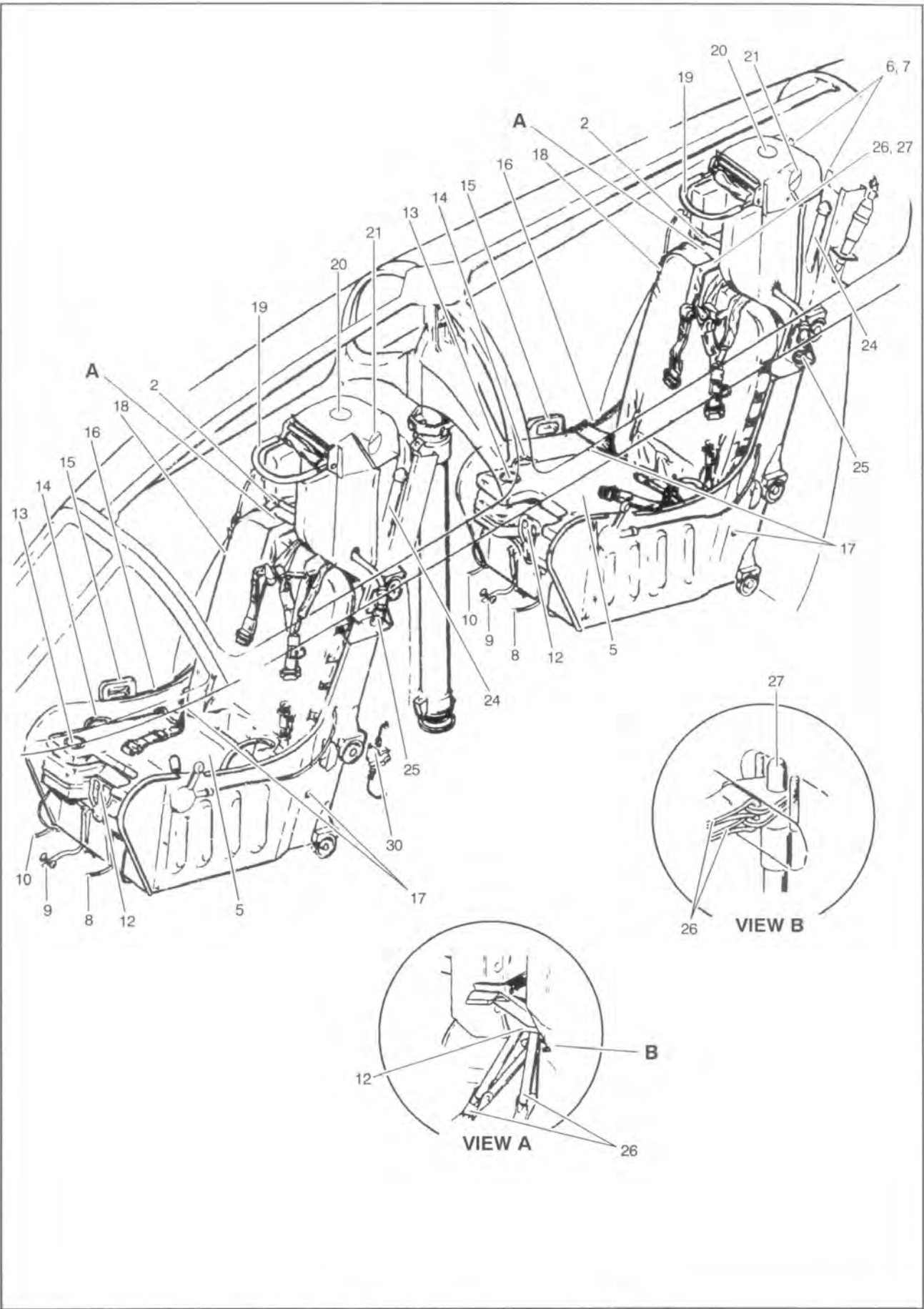


Figure 2-3 TA-4 1-G3 Ejection Seat Preflight

AL 6(0)

TA-4 Rear Cockpit

2.4 The following checks are to be carried out on the rear cockpit of the TA-4 prior to flight. When the A/TA-4 is flown solo, or with a non A/TA-4 qualified passenger, these checks are to be carried out prior to strap in. When the rear seat is occupied by a A/TA-4 qualified aircrew member, the checks can be carried out after strap in and prior to start.

		<u>DUAL</u>	<u>SOLO</u>
1.	Ejection Seat	NORMAL PREFLIGHT	RESTRAINED
2.	Oxygen Switch	TEST/NORMAL	NORMAL
3.	Manual Fuel Shutoff	NORMAL GUARD DOWN	NORMAL GUARD DOWN
■ 4.	Wing Fuel Switch	OFF	OFF
5.	Drop Tank Switch	OFF	OFF
■ 6.	Fuel Control Switch	PRIMARY LIGHT ON	PRIMARY LIGHT ON
7.	Spoiler Switch	OFF	OFF
8.	NWS Switch	NORMAL	NORMAL
9.	Drag Chute Switch	STOW	STOW
10.	Emergency Landing Gear Release Handle	SECURE	SECURE
11.	Emergency Ext Stores Jettison Handle	SECURE	SECURE
12.	Left Display Unit	DAY/NIGHT A/R	OFF
■ 13.	Vertical Speed Indicator	SERVICEABLE 0±100 FPM	
14.	Altimeter	SERVICEABLE 0±60 FT	
15.	Combined Speed Indicator	SERVICEABLE	
16.	EPR Gauge	CONDITION. SET	
■ 17.	LOX Gauge	QTY OX	
18.	Emergency Select	ALL	
19.	RPM Gauge	CONDITION	
20.	Cabin Altimeter	CONDITION ±200 FT	
21.	Manual Flight Control Handle	SECURE	
22.	Emergency Generator Release Handle	SECURE	
23.	Hook Handle	UP	
24.	Canopy Jettison Handle	SECURE	
25.	Oil Pressure Gauge	CONDITION	
26.	ADI	CONDITION CAGED	
27.	HSI	CONDITION	
28.	EGT Gauge	CONDITION	
29.	Right Display Unit	DAY/NIGHT A/R CONDITION	OFF

AL 6(0)

30.	Fuel Flow/Qty Gauges	CONDITION	
31.	Trim Position Gauges	CONDITION	
32.	NAV Panel	SET	
33.	ARC 159	ON	ON,
		FREQ SELECT	FREQ SELECT
		VOL ADJUST	
34.	Audio Panel	SET/CX AS PER FRONT SEAT	
35.	Internal Lighting	AS REQD	
36.	Anti-Icing	OFF	OFF
37.	Emergency Generator Switch	NORMAL	NORMAL
38.	Air Distribution Lever	AS REQD	HEAD
39.	Temperature Control Knob	COLD	COLD

EXTERNAL INSPECTION

NOTE

Ensure trigger latch (releasing mechanism of primary latch) on all access doors is installed so that the push portion is FWD and spring tension within the trigger latch is adequate to ensure positive locking action.

Cockpit Area and Forward Fuselage

- | | | | |
|--|---|--|-------------------------------|
| 1. Canopy Surface and Seal | CONDITION | 12. Nose Compartment | |
| 2. Left Intake Blank | REMOVE | Cooling Air Intake | CLEAR |
| 3. Intake Duct | FREE OF
FOREIGN OBJECTS | 13. Air Refuelling Probe Cover | REMOVE |
| 4. Left Intake Blank | REPLACE | 14. Static Pressure Vent (right side) | CLEAR |
| 5. Pitot Tube Cover | REMOVED | 15. External Canopy | |
| 6. Total Temperature | | Jettison Handle | STOWED, ACCESS
DOOR CLOSED |
| Sensor Cover | REMOVED | 16. Controls Access Panel | SECURE |
| 7. Angle-Of-Attack | | 17. Nosewheel Well Door | CONDITION,
SECURITY |
| Vane | COVER REMOVED,
CONDITION,
FREE MOVEMENT | 18. Fuse Panel Cover | SECURE |
| 8. Air-Conditioning and | | 19. Air-Conditioning Ground | |
| Exhaust Ducts | CLEAR | Test Plug | CONDITION,
SECURITY |
| 9. Engine Bleed Static Port | CLEAR | 20. Door Latch Forks | OPEN, SECURE |
| 10. Static Pressure Vents (left side) | CLEAR | 21. Nosewheel Steering | |
| 11. Nose Compartment Panels ... | CONDITION,
SECURITY | Assembly | CONDITION,
SECURITY |
| | | 22. Nosewheel Spindle Nut | CONDITION,
SECURITY |
| | | 23. Nosegear Downlock Pin | INSERTED |
| | | 24. Nosewheel Strut | EXTENSION,
NO LEAKAGE |

AL 7(6)

25. Nosewheel Tyre CONDITION
26. Nosegear Actuator CONDITION
27. Emergency Generator RETRACTED,
SECURE
28. Gun flash Suppressor and Gun SECURE
29. Right Intake Blank REMOVE
30. CFG Door SECURE
31. Intake Duct FREE OF FOREIGN
OBJECTS
32. Right Intake Blank REPLACE
33. Forward Engine
Compartment CONDITION,
SECURITY
34. Gearcase Oil Drain
Line Cap SECURE AND
LOCKWIRED
35. Aileron Power Package CHECK
ALIGNMENT
MARKS

Right-Hand Wheelwell

1. Main Gear Lockdown Pin INSERTED
2. Main Gear Shock Strut MIN OLEO
EXTENSION,
0.75-2 INCHES AND EVEN,
NO LEAKAGE,
STRAP ALIGNMENT

NOTE

An incorrectly serviced strut (insufficient oleo extension) may lead to unsafe gear up and potential hung gear situation after take-off.

3. Main Gear Actuator CONDITION
4. Main Wheel Tyre CONDITION
5. Brakes CONDITION,
NO LEAKAGE
6. Fuel System Vent CLEAR
7. Door Latch Forks OPEN, SECURE
8. Gun Pneumatic
Pressure Gauge 1500 psi MIN.
9. Armament Safety Disable Switch SAFE

10. Main Wheelwell Doors CONDITION,
SECURITY
11. Taxi Light CONDITION,
SECURITY

Right-Hand Wing

1. Wing NO WRINKLES,
CRACKS,
LOOSE RIVETS,
FUEL DEPOSITS
2. Wing Rack Stores SECURE
3. Drop Tank FILLER CAP SECURE
4. Wing Slat FREE MOVEMENT

WARNING

Operate each slat by hand to make certain that each slat extends and retracts with negligible effort and without binding. Binding which causes asymmetric slat extension requires excessive lateral control deflection to maintain wings level after or during accelerated stalls and landing approaches.

NOTE

Slat tracks and rollers should be free of grease and dirt.

Inspect slat track attach points for condition/security.

Push on the middle of the slat to check for smooth tracking upward. All points of the slat should contact the wing simultaneously. Check for upper and lower trailing edge gap uniformity.

Release the slat slowly checking for smooth downward travel. All slat tracks should bottom-out evenly.

Grasp leading edge of slat and check for excessive lateral movement.

Grasp underside of leading edge and lift up with forward tension to check for excessive vertical movement.

5. Navigation and Fuselage
Wing Lights CONDITION
6. RWS Antenna CONDITION

AL 8(7)

7. Aileron and Wing Flap CONDITION,
BONDING
8. Spoiler CONDITION, BONDING
9. Wing Tank Filler Cap SECURE

WARNING

Failure to properly secure the wing tank filler cap may lead to catastrophic fuel fire and/or explosion.

Aft Fuselage and Tail Section

1. All Access Doors CLOSED
2. Aft Engine Compartment CONDITION,
SECURITY
3. Flap Actuator CONDITION
4. Drop Tank Fuelling Switch OFF

NOTE

Drop Tanks will not supply fuel to the wing if fuelling switch is left in **ON** position

5. Engine Fuel Drain Lines CONNECTED
6. Pitot Drain Line Covers SECURE
7. CDS Programmer PROGRAMMED,
SECURITY
8. KY 58 ON, VOLUME MAX,
VARIABLES SET,
MODE C, VARIABLE DATE
CHECK, UNIT SECURE

WARNING

Do not pull any cable in the aft engine compartment bay. Inadvertent full or partial elevator disconnect or lowering of the arresting hook may result.

9. Speedbrake CONDITION,
SECURITY
10. LOX Compartment ENSURE PROPER
CONNECTION OF
OXYGEN SUPPLY
LINE AND OXYGEN
VENT LINE
SECURITY

11. Tailpipe Cover REMOVED
12. Tailpipe NO CRACKS,
WRINKLES,
BURNS, FUEL DEPOSITS
13. Tail Light CONDITION
14. RWS Antennas CONDITION
15. Rudder, Elevator and
Horizontal Stabiliser CONDITION,
BONDING
16. VOR/ILS Antennas CONDITION
17. Drag Chute Safety Pin REMOVED
18. Drag Chute Release Rod
and Guides SECURITY,
CLEARANCE
19. Drag Chute Attachments SECURITY,
CIRCLIP INSTALLED
20. Speedbrake CONDITION,
SECURITY
21. Arresting Hook RETRACTED,
CONDITION
22. Tension Bar Retainer CONDITION
23. IFF Mode 2 SET AS REQUIRED
24. Arresting Hook Holddown
Cylinder Pressure Gauge 900±50 psi
25. CDS Pin FITTED IF CDS LOADED

Left-Hand Wing

1. Wing Flap and Aileron CONDITION,
BONDING
2. Aileron Tab CONDITION
3. Spoiler CONDITION,
BONDING
4. Navigation and Fuselage
Wing Lights CONDITION
5. RWS Antennas CONDITION
6. Wing NO WRINKLES,
CRACKS, LOOSE RIVETS,
FUEL DEPOSITS
7. Wing Slat FREE MOVEMENT
8. Wing Rack Stores SECURE
9. Drop Tank FILLER CAP
SECURE

Left-Hand Wheelwell

1. Main Gear Doors CONDITION,
SECURITY

- AL 8(7)
2. Main Gear Down Lock Pin INSERTED
 3. Main Gear Shock Strut MIN OLEO
EXTENSION,
0.75-2 INCHES AND EVEN,
NO LEAKAGE,
STRAP ALIGNMENT

NOTE

An incorrectly serviced left-hand strut (insufficient oleo extension) may lead to retraction release failure, unsafe gear up and potential hung gear situation after take-off.

4. Main Wheel Tyre CONDITION
5. Brakes CONDITION,
NO LEAKAGE
6. Main Gear Actuator CONDITION
7. Retraction Release
Solenoid CONDITION
8. Down Lock and
Microswitch CONDITION

Centre Fuselage Underside

1. Fuselage Rack Store SECURE
2. Centreline Fuel Tank FILLER CAP
SECURE
3. Forward Engine and Accessories
Section Access Doors CLOSED
4. Link and Case
Ejection Chutes CLEAR
5. Gun Flash Suppressor and Gun . . . SECURE
6. Controls Access Panel SECURE
7. External Canopy
Control Handle STOWED,
ACCESS DOOR CLOSED

PRE-START

2.5 The following procedures apply to the front cockpit. For TA-4 rear cockpit procedures, refer to PRIOR TO EXTERNAL INSPECTION procedures.

1. Power Panel ALL SWITCHES ON
2. NAS Panel ALIGN
3. ARC 159 SELECT BOTH,
FREQ/STUD AS REQD
4. Audio Panel ARC 182 ON
5. HUD Switch HUD

6. Display Units DAY/NIGHT A/R

NOTE

Power is not applied to the HUD, ARC 182 and DUs until the NAS panel INU switch is placed in align.

7. Controls STIFF
8. Emergency Speedbrake
knob NORMAL
9. KY 58 OFF, VARIABLES SET,
MODE PLAIN, DELAY OFF,
ZEROISE, OFF-GUARD DOWN
10. Oxygen Regulator LOCK-WIRED ON,
70 PSI MIN. SELECT NML AND 100%.
TEST PRESSURE RETURNS AFTER
EACH BREATH, NO RESTRICTIONS.
TEST EMERG. RESELECT NML. TEST
MASK
11. Role Equipment OFF/SET
12. AFCS STBY SWITCH OFF,
AILERON TRIM: NORMAL
13. Manual Fuel Shutoff NORMAL
(GUARD DOWN)
14. Wing Fuel Switch OFF
15. Air Refuel Switch NORMAL
16. Start/Abort Knob UP
17. Drop Tanks Switch OFF
18. Fuel Control PRIMARY,
LIGHT ON
19. Throttle FULL AND FREE
MOVEMENT, FRICTION A/R, SELECT
OFF, MASTER MODE TO NAV
20. Flap Lever UP
21. Rain Removal Switch OFF
22. Spoilers Switch OFF
23. Nose Wheel Steering Switch NORMAL
24. Master Exterior Light
Switch AS REQUIRED
25. Radar Control Panel OFF/SET
26. Drag Chute Switch STOW
27. Landing Gear Handle LOCKED DOWN

AL 8(7)

28. Emergency Landing Gear
Release Handle SECURE
29. Emergency Ext Stores
Jettison Handle SECURE
30. Left Display Unit CONDITION,
ERASE BIT HISTORY,
SELECT STATUS PAGE
31. Ladder Warning Lights FUEL TRANS
illuminated FUEL BOOST
OIL PRESS
CONTROL HYD
UTILITY HYD
32. Vertical Speed Indicator .. SERVICEABLE,
0 ±100 FT.
33. Master Arm Switch SAFE
34. Altimeter SERVICEABLE
35. Combined Speed SERVICEABLE,
Indicator INDICES SET
36. HUD STBY RETICLE
DEPRESSED, CONDITION,
CHECK ALIGNMENT
37. UFC INSERT TIME, LAT/LONG/
ELEV (IF REQD), LOAD DTM
38. ADI CONDITION, CAGED
39. HSI CONDITION
40. LOX QTY MIN 3 LTRS (A-4),
5 LTRS (TA-4)
41. Station Select Pushbuttons ... CONDITION
42. Emergency Jettison Selector ALL
43. Guns SAFE
44. AIM-9 Coolant Switch OFF
45. Manual Arm Switch SAFE
46. Manual Weapons Switch AUTO
47. Cabin Altimeter CONDITION
±200FT.
48. Manual Flight Control Handle ... SECURE
49. Emergency Generator
Release Handle SECURE
50. Hook Handle UP
51. Canopy Jettison Handle SECURE
52. Brakes PUMP PEDALS,
PARK BRAKE ON, LIGHT ON

53. Press to Test Button PRESS, CHECK
INDICATIONS,
20% AND 80%
OIL QTY CHECK

NOTE

LOW FUEL warning light should illuminate. Light may extinguish after a few seconds, but must not flicker.

54. Engine Instruments CONDITION
55. Radar Warning Display CONDITION
56. Right Display Unit CONDITION
57. Radar Altimeter Switch OFF
58. Fuel GAUGE CONDITION,
EXTERNAL FUEL CHECK,
RESELECT INTERNAL
59. Trim Position Gauges CONDITION
60. Countermeasures
Dispenser Panel OFF, SET
61. Radar Warning Panel OFF, SET
62. NAV Panel SET,
REFERENCE-NAS

NOTE

To obtain the correct indications during I-BIT, the Reference switch must be selected to NAS.

63. Audio Panel SET
64. IFF OFF, CHANNEL SET
65. Internal Lighting AS REQUIRED
66. TACAN OFF, CHANNEL SET
67. AVTR STBY
68. TACAN Antenna AUTO
69. Emergency Generator Switch ... NORMAL
70. Anti-Icing Switch OFF
71. Cabin Temperature Control SET

NOTE

It is recommended that all defrost air be diverted to the foot warmer for takeoff. Direct eyeball diffusers away from face.

72. Pressurisation NORMAL

AL 8(7)

- 73. Windshield Defrost (A-4) HOLD
- 74. Air Conditioning Switches (TA-4) ON
- 75. External Lights AS REQUIRED
- 76. White Floodlights AS REQUIRED
- 77. Fuel Transfer Bypass
Switch (TA-4) NORMAL
- 78. Anti-Collision Light ON

ENGINE STARTING

Before Starting The Engine

2.6 Make certain that the areas forward and aft of the aircraft are clear of personnel and loose objects. Make certain that fire fighting equipment is available and manned, and that the boarding ladder and engine blanks are removed.

Starting The Engine

2.7 An electrical power supply of 115 VAC, and a source of starter air are required for starting the engine on the ground. The three methods of starting the engine are pilot-controlled starts, modified pilot-controlled starts, and ground-controlled starts.

Pilot-Controlled Starts

2.8 A pilot-controlled start requires a source of 3Ø 400 Hz, 115/200 VAC external aircraft power, and an air start unit that provides 28 VDC electrical power. To provide automatic air supply shutoff at the correct starter cutout speed, the aircraft starter circuit receptacle must be connected electrically to the gas turbine power unit prior to starting attempts. The ground air supply shuts off automatically at approximately 50 percent engine rpm unless a malfunction occurs, in which case the air supply must be shut off manually by pulling up on the engine starter switch.

Modified Pilot-Controlled Start

2.9 A modified pilot controlled start may be made whenever an external source of 3Ø 400 Hz electrical aircraft power is unavailable, and the air start unit can provide 28 VDC, and 115 VAC single phase electrical power. Air supply shutoff is the same as for the pilot controlled start.

NOTE

No aircraft instrument indications except RPM and EGT will be available during the start cycle until the generator comes on line.

Ground-Controlled Starts

2.10 A ground-controlled start must be made whenever the air start unit cannot provide 28 VDC electrical power. The pilot has no control over air supply shutoff.

NOTE

An external source of 3 phase 400 Hz electrical aircraft power must be available.

2.11 Pilot-controlled starts should be made whenever possible to avoid starter motor overspeed. The time delay inherent in initiating or shutting off the starter air supply, when using hand signals, makes the ground-controlled start less desirable.

WARNING

Starter motor overspeed can be severe enough to cause starter motor damage, or failure, with a resultant hazard to personnel and equipment.

Start Procedure

1. Engine Blanks REMOVE
2. Fire Extinguisher AVAILABLE
3. Ground Crew IN POSITION
4. Show 1 Finger to Start
Crew GTC STARTED,
GTC CREW SIGNAL
GTC READY
5. Start Abort Knob DEPRESS
Simultaneously Show 2
Fingers to GTC Crew .. GTC CREW TURN
START VALVE ON

NOTE

The Start Abort Knob needs to be depressed for pilot controlled and modified pilot controlled starts only.

6. 5% RPM THROTTLE
IGNITION (TWICE)

AL 9(7)

7. 15% RPM THROTTLE IDLE,
FUEL CONTROL LIGHT OUT,
CHECK FUEL FLOW

NOTE

Fuel Control Light and Fuel Flow Gauge will not operate during modified pilot controlled starts until the generator comes on line.

NOTE

The Manual Fuel Control warning light must be out by 25% RPM.

8. Lightup AT APPROX.
20% SIGNALLED
BY GTC CREW
9. 50-54% RPM START ABORT
KNOB UP

Simultaneously Show 3

Fingers to GTC Crew GTC CREW
CHECK/TURN START VALVE OFF,
DISCONNECT STARTING AIR
HOSE AND ELECTRICAL
CABLE, SECURE ACCESS PANEL

CAUTION

To prevent starter motor overspeed ensure that the start abort knob is up prior to 54% RPM. If the start abort knob remains engaged, then manually raise knob.

NOTE

RPM, oil pressure and EGT should be monitored throughout the start.

2.12 Lightoff should occur within 20 seconds after moving throttle outboard to start ignition cycle. Lightoff will be indicated by rise in EGT after throttle is moved to IDLE position. Normally, engine should be stabilized at IDLE rpm within 45 seconds after depressing engine starter button.

Engine Starter Cycle Limits

2.13 Bendix or AiResearch starters are fitted. Both have different start cycle limits. However, the following operating limits are to apply to both types of starters:

2 x 1 minute cranking cycles with 10 minutes between followed by a 15 minute wait before resuming the start cycle again.

Engine Idle Curves

2.14 The Engine Idle Check Curve for various ambient air temperatures is shown in Figure 2-4.

Chugs and Stalls

2.15 If chugging is encountered during an acceleration, there will be a momentary RPM hesitation without an EGT rise. Engine stall may or may not be accompanied by chugging. If a stall does occur, the RPM will hang up or decrease and the EGT will rise. Should either a chug or a stall occur, shut down the engine and investigate.

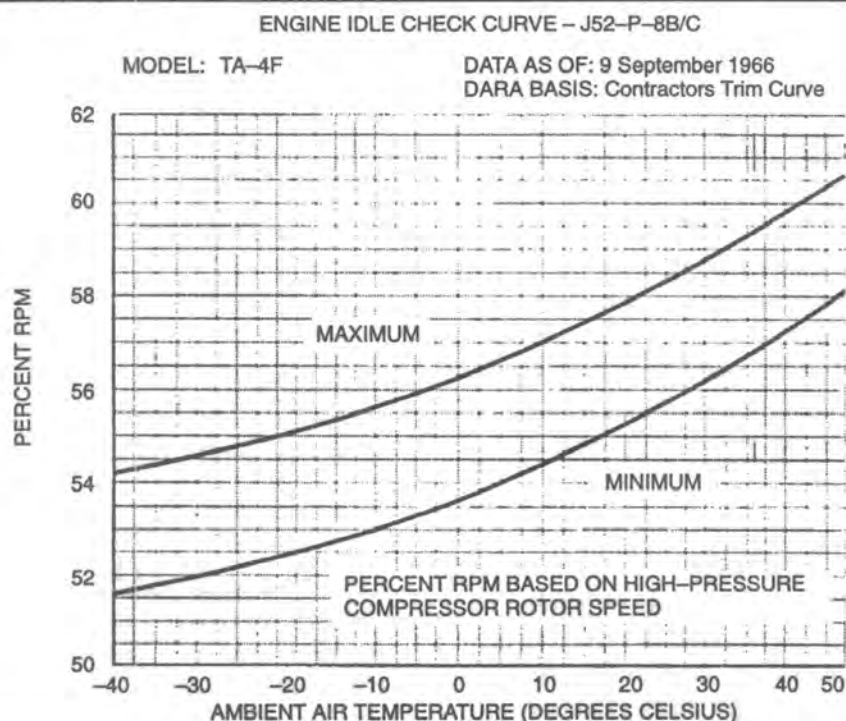


Figure 2-4 Engine Idle Check Curves

AL 8(7)

AFTER ENGINE START

2.16 If lightoff is satisfactory and engine speed is stabilised with the throttle at IDLE, check the following:

1. RPM IDLE. CHECK FOR
ACCEPTABLE RPM
AS DEFINED IN
Figure 2-4
2. EGT 200 to 340°C

NOTE

At IDLE RPM, temperature pointer will normally stabilize at position below maximum indicated. The 340°C temperature is not a limit but a guide to indicate EGT which, if exceeded, may signify an engine malfunction.

3. Oil pressure 40 to 50 PSI

NOTE

The oil pressure indication at IDLE RPM should be 40 to 50 psi. A minimum oil pressure of 30 psi is acceptable for ground operation provided oil pressure rises to above 40 psi at 60% RPM. If oil pressure fails to rise above 40 psi, the engine should be shut down and the cause for low oil pressure determined.

4. Oil quantity indicator/switch . LIGHT OUT

NOTE

Due to oil system drainage or low ambient temperature the 20% oil light may come on at start. If oil pressure is within limits, engine operation for 12 minutes at idle RPM will scavenge, aerate, and heat oil.

The 80% oil light may come on when depressed due to same conditions. With acceptable oil pressure, engine operation at 75% RPM for 8 minutes will completely scavenge, aerate, and heat oil.

5. Fuel boost ladder light OUT

NOTE

If the fuel boost light is still on, the generator may have failed. Total loss of electrical power may occur on removing ground power, and the INU battery will be depleted.

6. Ground Power DISCONNECT

7. Rain Removal TEST THEN OFF,
CAUTION LIGHT ON/OFF
8. ICS (TA-4) ACKNOWLEDGEMENT,
FORE AND AFT COCKPITS
9. Canopy (TA-4) DOWN,
RIFLE BOLT IN LOCK DETENT,
CANOPY WARNING LIGHT OUT,
LATCH HOOKS PROTRUDE
INTO STRIKER PLATES,
OXY/ANTI-G HOSES CLEAR
OF CANOPY HANDLE

NOTE

While locking the canopy, ensure the detent action is present on the control handle. This is indicated by an 'over centre' feel on the locking handle which allows the handle to spring forward on closing.

10. Headknocker UP

2.17 The pilot in command is to ensure that both headknockers are in the same position at all times when both seats are occupied.

Engine Ground Operation

2.18 No warm-up period is necessary. Always use the minimum RPM deemed necessary to minimize the possibility of damage from foreign objects.

CAUTION

During ground operations with the canopy open, keep loose articles in the cockpit at absolute minimum.

Do not carry articles in the external shoulder pockets of the flight suit.

Do not set objects on instrument shroud in rear cockpit of the TA-4.

Do not pass objects to or from ground crewmen with engine operating. This practice has proved dangerous in causing ingestion of foreign objects into the engine and subsequent damage to blading.

Do not enter/exit the cockpit from either crew position with engine operating unless intake screens are installed.

AL 8(7)

11. KY 58 AS REQUIRED

NOTE

When the KY-58 is turned ON, a continuous beeping (Crypto-alarm) with background noise will be generated. Clear this by keying the ARC-182 once. The absence of the beeping and background noise at power ON indicates a malfunction.

12. AFCS STANDBY

13. Drop Tanks PRESSURIZE

14. Wing Fuel Switch SELECT EMER TRANS:
EMERG TRANS LIGHT ON,
FUEL TRANS LIGHT OUT.
SELECT EMER TRANS OFF:
EMERG TRANS LIGHT OUT,
FUEL TRANS LIGHT ON.
IF EXTERNAL
CONFIRMATION REQD.,
REFER 4 FINGER CHECK.

NOTE

If fuel stores on centre station are not pressurized prior to selecting emergency transfer, inadvertent dumping from store vent outlet could occur.

15. Radar STBY

16. ADI UNCAGE AND ERECT

17. Radar Warning Panel ON

18. Audio Panel VOR/ILS ON

19. IFF STBY

20. TACAN T/R

21. Oil Quantity 80% CHECK

AIRCRAFT CHECKS

2.19 In conjunction with dispatch crew:

1. Hydraulic System WITHIN LIMITS

2. Landing Gear Pins 3 SHOWN

3. Flying Controls FULL AND FREE

WARNING

Do not operate any hydraulically operated equipment until the dispatcher has cleared the aircraft after checking the hydraulic system and removed the landing gear pins.

CAUTION

If any jamming or restriction is encountered, no effort should be made to free the controls by force. Instead, a light pressure should be maintained on the restriction while maintenance personnel investigate. Once investigation has begun, controls should only be moved when directed by the maintenance personnel.

4. Flap SET 1/2

5. Speedbrakes .. OUT (Note stick movement)

6. Spoilers ARMED

7. Hook DOWN

8. Sniff Check GIVE GROUND
CREW CLEARANCE9. AFCS PERFORM TEST 1,
AND 2**NOTE**

At completion of AFCS 2 check, ensure that the AFCS has been disconnected.

10. Radar Warning Panel PERFORM BIT

11. Radar Altimeter Switch SET A/R

NOTE

If the radar altitude is on during RWS BIT spurious RWS failures may occur.

12. NAS I-BIT AS REQUIRED

13. Rudder Trim CHECK OPERATION,
SET AT 0

14. Horizontal Stabilizer
Trim and Manual
Override Lever CHECK OPERATION,
SET 8 DEG NOSE UP
(10 DEG TA-4 > 21,500 LBS)

15. Aileron Trim CHECK OPERATION,
SET 0, (STICK
CENTRED)

AL 7(6)

16. Horizontal Stabilizer TAKE-OFF
SETTING
CONFIRMED BY
GROUND CREW WITH
2 FINGERS AND
"THUMBS UP"
SIGNAL
17. Speedbrakes IN
18. Arresting Hook UP/LIGHT OUT
19. 4 Fingers
(If required due no
FUEL TRANS Light) SELECT EMER
TRANS. WHEN
GROUND CREW
POSITIONED, WING
FUEL SWITCH OFF
20. 5 Fingers DEPRESSURIZE
DROP TANKS
21. HUD CHECK
ALIGNMENT
COMPLETE
22. NAS Panel SELECT NAV
AS REQD
- 23. Park Brake ON
24. Chocks REMOVE

TAXI

2.20 Advance throttle to a maximum of 70 percent before:

1. Park Brake RELEASE

2.21 When the desired taxi speed is reached, retard throttle to IDLE. Use caution in confined or restricted areas.

NOTE

In the TA-4 it is recommended that all taxiing be accomplished with canopy closed to prevent undue stress on hinges. If, however, pilot heat fatigue becomes a problem, taxiing may be done with the canopy on the stops (in the mouse-trap position)

2. Brakes CHECKED – BOTH
COCKPITS
3. NWS CHECKED – BOTH
COCKPITS

2.22 Check nosewheel steering system for correct operation during taxi as follows:

- a. With nosewheel steering engaged, check responsiveness of the system left and right to ensure that the nosewheel is driven accurately in conjunction with rudder pedal displacement.
- b. While taxiing straight ahead, disengage nosewheel steering and note any tendency to turn. Taxi in this condition for a sufficient distance to determine that the true tendency has been demonstrated. A steady, slight turn is not a major malfunction and is probably indicative of mismatched main strut extension, misalignment of nosewheel centre, or a moderate cross wind component.

WARNING

Failure of any of the nosewheel steering check-out procedures may result in loss of directional control during take-off or landing, and the system should be checked by maintenance personnel prior to flight.

2.23 Maintain directional control using nosewheel steering and brakes, as necessary.

2.24 In the TA-4 hand control over to the rear cockpit pilot so that the brakes and nosewheel steering can be checked in the rear cockpit.

4. Turn and Slip INDICATING
CORRECTLY

AL 8(7)

5. HUD/HSI/Stby Compass HEADINGS
COMPARE AND
CORRECT
6. HUD/ADI Pitch Bars REMAIN LEVEL
IN TURN
7. Nav aids/Steer To Destination CORRECT
INDICATION
8. DU SYSTEM Page CHECK
9. DU STATUS Page CHECK

2.25 While taxiing, determine that the nose strut is not overinflated by observing that the nose strut will compress when brakes are applied firmly. The oxygen mask should be donned while taxiing when the canopy is closed and the pressurization is on.

PRE TAKE OFF

2.26 Referring to the TAKEOFF checklist placard (FO-1), check the following:

1. Trims RUDDER
CENTRAL,
ELEVATOR 8 DEG
NOSE UP (10 DEG
TA-4 >21,500 LBS),
AILERONS FAIRED
2. Harness LOCKED AND
TIGHT, LAP STRAPS TIGHT,
3 PINS, VISOR, CHIN STRAP,
HEADKNOCKER, G-SUIT, EJECTION
SELECTOR (TA-4)
3. Canopy CLOSED
In the TA-4 check RIFLE BOLT
FORWARD,
LIGHT OUT,
6 LUGS FWD COCKPIT,
6 LUGS REAR.
In the A-4 check HANDLE OVER
CENTRE, CANOPY
HOOKS ENGAGED
IN ROLLERS

NOTE

In the TA-4, due to cockpit constraints, some pilots may be unable to visually check the two rear most lugs.

4. Flap SET $1/2$
5. Speedbrakes IN

6. Armament ALL SWITCHES
OFF/SAFE.
EMERGENCY
JETTISON
SELECTOR ALL
OR AS REQUIRED
7. Spoilers ARMED, LADDER
LIGHT ON
8. Drop tanks PRESSURIZE
9. Flying Controls FULL AND FREE
10. Takeoff/Departure
Brief (TA-4 Dual) COMPLETE

RUNWAY CHECKS

2.27 Line up on the runway ensuring that the nosewheel is straight. Ensure that the park brake is OFF.

1. AVTR RUN/HUD
2. ICS (TA-4 Dual) ON
3. IFF NORM (IF REQD)
4. Anti-Icing PITOT OR ALL AS REQD
5. Taxi light ON
6. Throttle 85% RPM
7. Spoilers CLOSED
8. Fuel Control MANUAL
9. Fuel Flow/EPR FLUCTUATION
10. Fuel Control Light ON
11. RPM DROP WITHIN LIMITS
Refer Figure 2-5

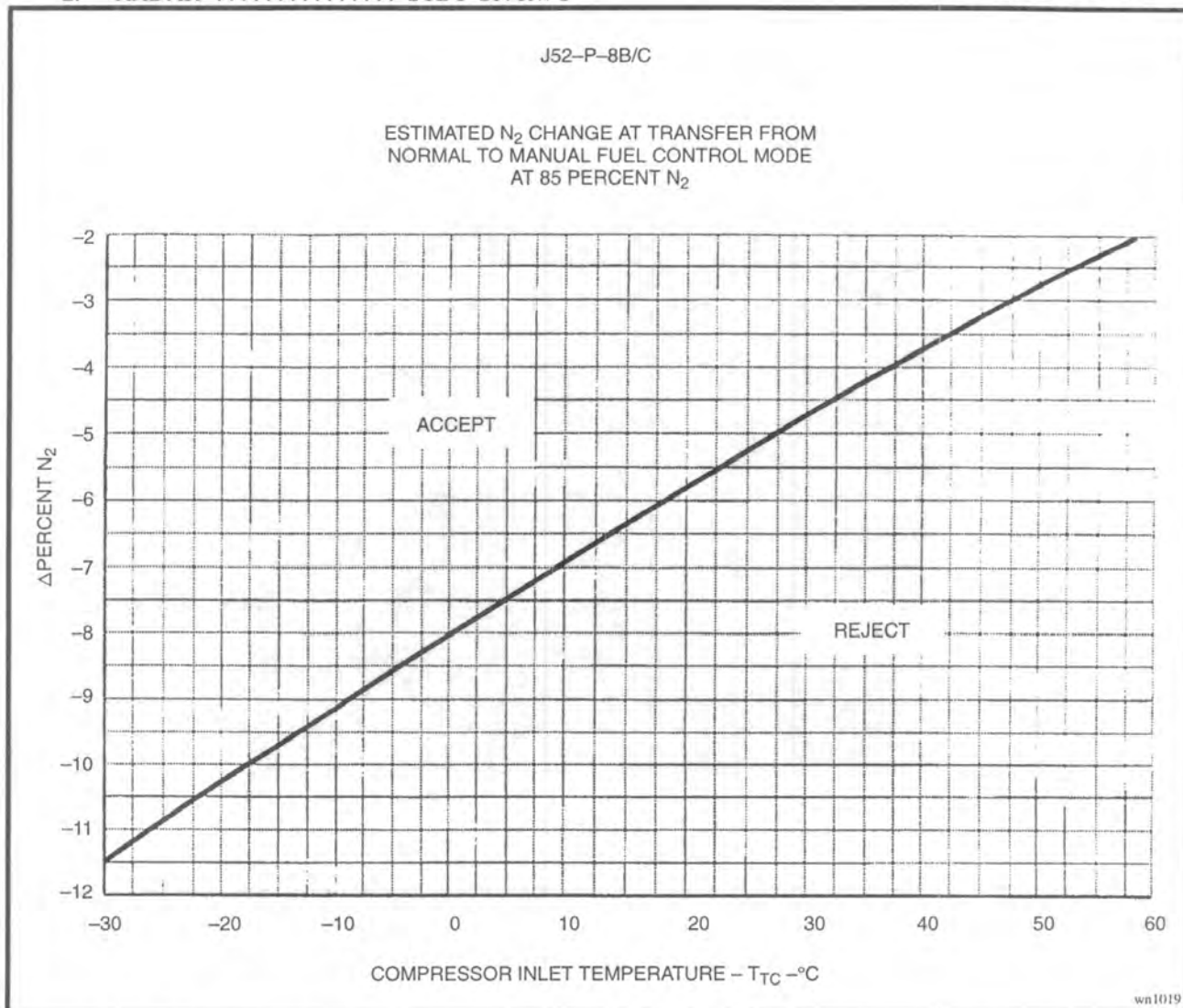
NOTE

Fuel Controls which have been flow bench adjusted on the high side of the manual fuel flow tolerance band may produce an RPM rise when shifting at 85%. As OAT increases, the probability of an RPM increase also increases. This rise is not indicative of a system failure.

12. Fuel Control PRIMARY
13. RPM RETURNS TO
ORIGINAL SETTING
14. Fuel Control Light OUT
15. All Caution and Ladder Lights OUT

AL 7(6)

- | | | | |
|----------------|-------------------|------------------|------------------|
| 1. NAS | ON AFTER STRAP-IN | 3. ARC-182 | OFF (IF ON GND |
| 2. RADAR | STBY ON RWY | | FOR LONG PERIOD) |

Figure 2-5 Estimated N_2 Change at 85 Percent N_2 at Manual Fuel System Transfer

TAKEOFF

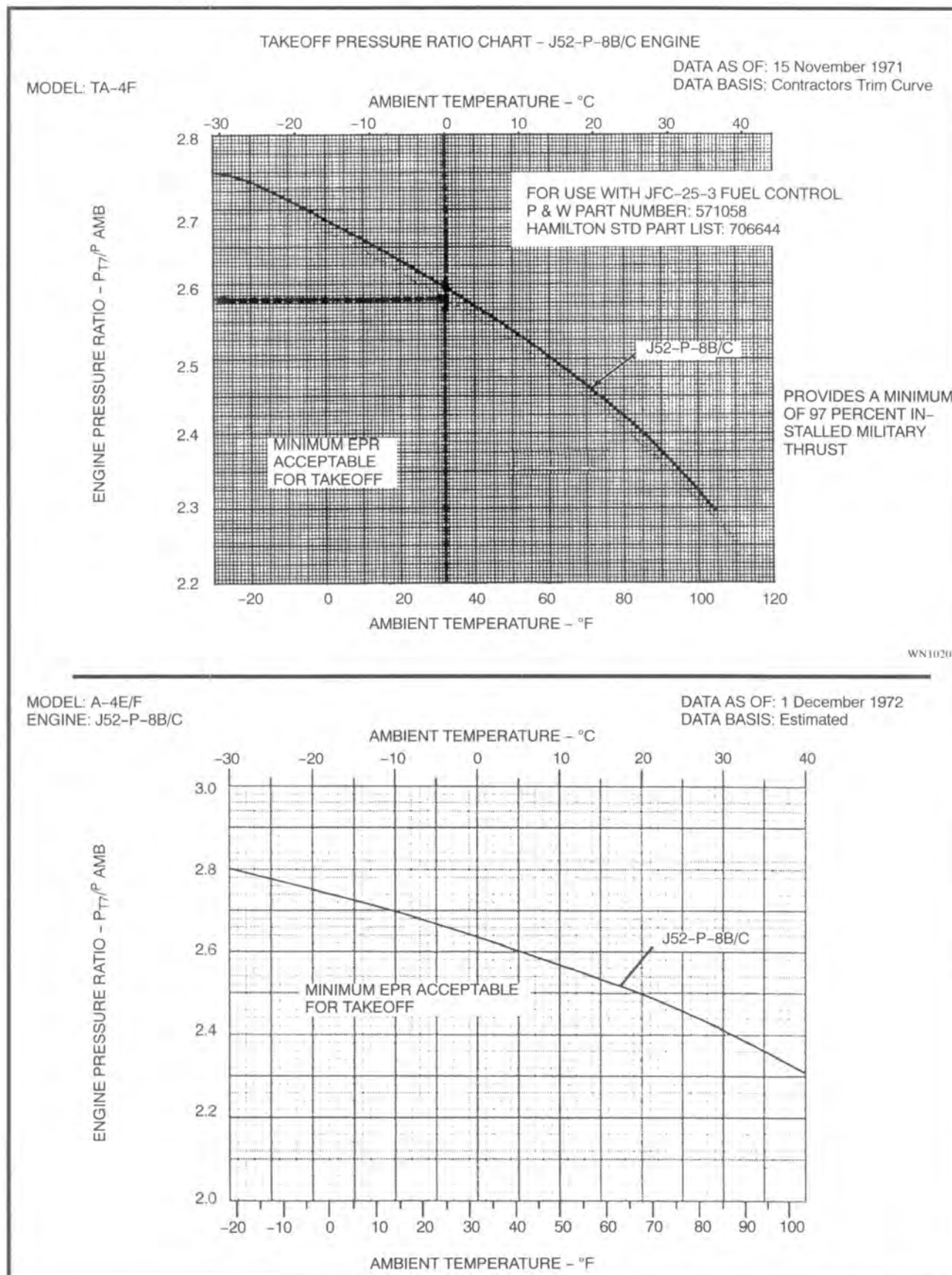


Figure 2-6 Takeoff Pressure Ratio Chart

AL 8(7)

TAKE-OFF CHECKS

1. Brakes RELEASE
2. Power MILITARY

2.28 Ensure that acceleration is within acceptable limits and that engine accelerates smoothly. When engine stabilizes initially, check the following:

3. EPR AT OR ABOVE BUG
Refer Figure 2-6

NOTE

Wind has a negligible effect on EPR readings.

4. RPM 95-101%
5. EGT 680 MAX
6. Oil Pressure 40-50 PSI
7. Horizontal Stabiliser AS SET
8. All Caution and Ladder Lights OUT

2.29 Use brakes to maintain directional control until rudder becomes effective (about 70 knots).

WARNING

Due to the possibility of uncommanded hydraulic inputs, which can result in unexpected swerving and loss of control when the nosewheel steering button is released, nosewheel steering should not be used during take-off roll unless an emergency dictates otherwise.

2.30 On rough runways, nosewheel bounce may be experienced. Apply forward stick as necessary to maintain nosewheel on the runway.

CAUTION

Excessive forward stick pressure may cause a blown nose tyre during take-off run.

The maximum crosswind component is 25 knots.

9. Line Speed CHECK

2.31 Check the predicted line speed at selected distance marker. This check point should be selected so as to allow normal braking technique to stop the aircraft on the runway remaining.

2.32 At 10 knots prior to predicted take-off speed, raise the nose to a take-off attitude and allow aircraft to fly itself off the runway.

NOTE

The amount of nose gear strut extension has no significant effect on lift-off speed, control forces, or trim position required. Refer to Chapter 9 for additional information on take off airspeed and ground roll distance.

2.33 Formation take-offs are not recommended with a crosswind component in excess of 8 knots.

2.34 If strong crosswinds exist, take-off along the upwind side of runway and apply forward stick as necessary to hold the nose-wheel on the runway until computed take-off speed is reached. Deflect stick into wind as necessary to maintain wings level. Use brakes to maintain directional control until rudder becomes effective (about 70 KIAS).

AFTER TAKE-OFF

2.35 When safely airborne, proceed as follows:

1. Brakes APPLY, THEN OFF

2.36 Apply brakes momentarily to stop main gear tyre rotation before wheel enters wheel well.

2. Landing Gear UP, CHECK INDICATIONS

3. Flap UP

2.37 When take-off weight is less than 21,500 lbs AUW do not raise the flaps prior to 170 KIAS. Above 21,500 lbs AUW achieve 200 KIAS prior to raising the flaps.

4. Spoilers OFF
5. Stab Aug ENGAGED
6. Radar MODE AS REQD
7. Taxi Light OFF
8. Strobe Light ON

AL 7(6)

NOTE

Almost constant nose down trimming of the horizontal stabilizer will be necessary after takeoff during the period of acceleration to best climbing speed.

2.38 Be prepared for the possibility of unusual noise or vibration during the first minute after takeoff, caused by an unbalanced nosewheel tyre. An unbalanced nosewheel tyre creates a strong vertical vibration of decreasing frequency which can be sensed to emanate from the nose section. DO NOT assume that this is the case if unusual noises occur after takeoff. Do analyze engine instruments and feel of aircraft. Be prepared to take action until noise/vibration ceases as indicated above.

Wet Runway Take-Off

2.39 Takeoffs on wet runways when crosswinds exist must be undertaken with extreme caution. Directional control can be lost at surprisingly low speeds early in the takeoff roll. TA-4 aircraft tend to turn away from a crosswind when normal tyre friction exists due to the large side area forward of the main landing gear about which the aircraft turns. However, as the aircraft accelerates through the speed region where the aerodynamic surfaces become effective (about 60–80 KIAS), standing water, runway paint, or rubber deposits may reduce tyre friction to a point where the aircraft will “weather-cock” into wind. If standing water is patchy, the aircraft may alternately turn into wind, then away from it as tyre friction decreases then increases. Directional control difficulties will be aggravated in strong or gusty crosswinds because the spoilers will be closed. Excessive control inputs may induce swerving that may further aggravate the condition. Once a drift has begun on a slippery surface, it will be extremely difficult to stop. Runway width may be insufficient to keep the aircraft from going off the side. If takeoff must be accomplished on a wet runway during crosswind conditions, follow the procedures in this section, being careful not to over-correct for any drifting or skidding.

Minimum Run Take-Off

2.40 Minimum distance takeoff technique of nosewheel lift off and full noseup trim will result in only a very minor

improvement in takeoff distance (approximately 200 feet at all gross weights tested) and no improvement in 50 foot obstacle clearance distance. If take off distance is predicted to be marginal, strong consideration should be given to reducing gross weight as a means of assuring adequate takeoff and 50 foot obstacle distances.

2.41 To accomplish a minimum run takeoff, full noseup trim and half-flaps should be employed. Use of full flaps delays nosewheel liftoff. After brake release, as the aircraft accelerates down the runway, a generous amount of aft stick should be used to effect nosewheel liftoff. Full aft stick deflection may result in an inadvertent trim input due to interference with pilot survival equipment. During aircraft liftoff (about 10 KIAS less than normal), a noseup rotation of the aircraft will occur, which will require an immediate reduction in aft stick pressure to control. As the aircraft accelerates to climbing speed after takeoff, almost constant retrimming of the stabilizer will be necessary. The noseup rotation of the aircraft at takeoff is reduced in abruptness and severity by an increase in gross weight or by use of less aircraft noseup trim. However, if less than full noseup trim or less than full aft stick is employed, minimum nosewheel liftoff speed will be increased.

Flaps Up Take-Off

2.42 Half flaps are recommended for all takeoffs. However, in the case of flap malfunction or the inadvertent leaving of the flaps in the up position, it is possible to safely complete the takeoff, provided the flaps-up takeoff speed does not exceed the safe tyre limit of 175 knots ground speed.

2.43 A flaps-up takeoff may be accomplished by increasing the half-flaps takeoff speed (Figure 9-13 and Figure 9-15) from 7 knots at 18,000 pounds to 9 knots at 24,500 pounds. This increase in takeoff speed results in an increase in ground run distance over that shown in Figure 9-13 and Figure 9-15 of 200 to 400 feet, respectively.

2.44 Caution must be exercised when attempting a flaps-up takeoff in order that the safe tyre speed limit of 175 knots ground speed is not exceeded. This restriction is, in effect, a limit on the maximum weight at which a flaps-up takeoff may be safely completed. This maximum weight is that weight at which the flaps-up takeoff speed is 175 knots ground speed.

AL 8(7)

IN-FLIGHT

Operating Checks

2.45 These checks should be carried out at 10 minute intervals when above 10,000 ft pressure altitude, and when climbing, at 10,000 ft intervals commencing from 10,000 ft.

1. Oxygen Hose Connections SECURE
2. Flow Indicator NORMAL
OPERATION
3. System Pressure 70 PSI MIN.
4. LOX Quantity SUFFICIENT,
CONSUMPTION NORMAL
5. Cabin Altitude NORMAL
6. Engine Temperatures and Pressures.....NORMAL

FENCE Checks

2.46 The following checks should be carried out prior to entering the exercise area or crossing the FEBA:

1. KY-58 SET
2. RADAR SET
3. Master Arm A/R
4. Guns READY
5. AIM-9 ON
6. RWR SET
7. CDS SET
8. IFF A/R

Low Flying Checks

2.47 The following checks should be carried out prior to low flying:

1. Visors DOWN
2. Rad Alt ON/MSD SET
3. HUD DECLUTTER

Attack Checks

2.48 The following checks are to be completed pre-IP to ensure that aircraft systems are optimised for the attack phase:

1. HUD RECLUTTER
2. Radar MODE A/R
3. Master Arm A/R
4. CDS SET A/R

Delivery Checks

2.49 The following checks are to be completed upon selection of AIR-TO-GROUND master mode, during an operational weapons pass or in the downwind of an academic weapons pattern.

1. HUD REQ PROGRAM AND
WEAPON LOAD
SELECTED
2. Master Arm AS REQD
3. Left DU CORRECT PROGRAM AND
PARAMETERS CONFIRMED
4. Station ON/READY lights AS REQD
5. Right DU RADAR IN AGR MODE
6. Fuel CONTENTS

Formation Join/AAR Receiver Checks

2.50 Prior to joining in close formation or for AAR:

1. Fuel Panel SET AS REQD
2. Radar STBY
3. Armament ALL OFF/SAFE
4. CDS OFF
5. Strobe Light OFF

Rejoin Checks

2.51 Prior to rejoin carry out the following checks:

1. Fuel CONTENTS,
CALCULATE LANDING
AUW/OPT AOA SPEED

NOTE

At a gross weight of 14,000 pounds, optimum AOA of 17 1/2 units (16 1/2 units TA-4) will occur at 125 KIAS.

Add 5 Kts for each 1000-pound increase over 14,000 pounds.

2. CDS OFF
3. NAV Panel SET AS REQD
4. IFF SET AS REQD
5. Radar AS REQD
6. Radar Altimeter SET
7. Altimeter QNH SET
8. Recovery Brief COMPLETE

LANDING

2.52 Prior to landing check the following:

- 1. Armament EMERG JETTISON: ALL, SWITCHES SAFE
- 2. Harness LOCKED AND TIGHT
- 3. Hook AS REQUIRED
- 4. Landing Gear DOWN, CHECK POSN INDICATORS
- 5. Flaps DOWN, CHECK INDICATIONS
- 6. Indexers LIT
- 7. Spoilers ARMED

WARNING

If the AOA indexers are not illuminated, do not arm the spoilers until the aircraft is firmly on the runway.

- 8. Brakes PUMP
- 9. Taxi Light ON

Final Checks

2.53 The following checks are to be completed on short finals prior to every touch and go, or landing:

- 1. Gear DOWN
- 2. Flap DOWN
- 3. Spoilers ARMED
- 4. Clearance OBTAINED

2.54 Speedbrakes increase the stalling speed by approximately 1 knot. If the AOA indication of 17 1/2 units (16 1/2 units TA-4) does not occur at the IAS as computed from Figure 9-89, check the flap position indicator to ensure that the aircraft is in the correct configuration. If a

discrepancy between AOA indexer and airspeed exists, recheck landing configuration and gross weight, and approach at recommended airspeed.

NOTE

If the angle of attack system has failed, or is suspect, the position of the wing slats may be used as an approximate speed check. The wing slats should be approximately one-half extended at approach speed, with gear and flaps down.

AFTER TOUCHDOWN

2.55 After touchdown carry out the following procedures:

- 1. Throttle IDLE

NOTE

The throttle must be retarded below the 70% RPM position to deploy the spoilers.

- 2. Stick FORWARD AND INTO WIND
- 3. Drag Chute DEPLOY
- 4. Brakes FUNCTIONAL CHECK BELOW 80 KIAS
- 5. Drag Chute JETTISON

2.56 Apply full-forward stick deflected into wind as necessary to maintain a wings level attitude. Apply rudder as required to track runway centreline. When rudder becomes ineffective (below approx 70 KIAS), use brakes for directional control; use nose-wheel steering only if necessary.

NOTE

A “touch and go” or go around may be executed on a standard day with a minimum of 4,000 feet remaining and 80 KIAS. Local conditions may allow a delay in initiation but must be approached with caution.

AL 8(7)

Normal Braking Technique

2.57 As a general technique, a steady pedal pressure should be applied and maintained during landing rollout. Brake pedals should be released and reapplied only as necessary in order to hold firm pedal pressure and position. On a normal landing, brakes are not required until below 80 KIAS when a functional check is carried out, followed by smooth, steady braking as required. The drag chute will provide sufficient initial deceleration.

CAUTION

The improved capacity of the dual disc brakes makes it possible to lock the wheel brakes at any speed, causing a tyre to blow. This is particularly significant on wet or greasy surfaces, painted markings, smooth surfaces, etc.

Minimum Distance, Maximum Braking Technique

2.58 Correct braking technique for a minimum distance landing roll requires moderate brake pedal pressure, without skidding tyres, as soon as aircraft weight is firmly on the main wheels. Brake pressure must then be increased as the aircraft decelerates because aircraft weight on the tyres increases as wing lift decreases, assisting braking effort.

2.59 The spoilers, when extended with full flaps, reduce wing lift by almost 84 percent and minimize aircraft weight change on the tyres as the aircraft decelerates. Brakes may be applied, as soon as the spoilers are extended, with a moderately heavy pressure that will be slightly increased as the aircraft speed decreases.

NOTE

The maximum braking technique should not be used for normal field landings where adequate runway exists for allowing the aircraft to decelerate below 80 KIAS before applying brakes.

The maximum braking technique should normally be used on a dry runway only.

2.60 To accomplish a minimum roll-out distance landing, the following procedure is recommended:

1. Carry out a normal approach and touchdown, deploy the drag chute as soon as the aircraft is on the ground.
2. After touchdown leave the flaps fully extended unless there is excessive crosswind.

3. Apply moderately heavy braking immediately after the nose-wheel is on the runway (dry runway only).
4. Maintain steady braking throughout the roll-out to a stop or desired taxi speed, increasing brake pedal pressure as the roll-out speed decreases.
5. If circumstances dictate, the landing roll may be further reduced by shutting down the engine at approximately 80 KIAS.

NOTE

Spoilers will close at engine shut-down.

Crosswind Landing

2.61 Crosswind landings are not recommended with a crosswind component in excess of 25 knots. During the approach, maintain wing down into wind and opposite rudder as required to keep the nose aligned straight down the runway. At touchdown, the aircraft should be tracking straight down the runway, with no drift. After touchdown, with crosswind components of 25 knots or less, the aircraft can easily be controlled directionally by applying aileron into wind and using wheel brakes as required. Nose-wheel steering may be used when rudder becomes ineffective. If the upwind wing is allowed to rise, the nose of the aircraft will tend to track toward the downwind side rather than "weather-cocking" into the wind as is normally expected. If strong crosswinds exist, land on the up-wind side of the runway.

CAUTION

Maximum recommended crosswind component is 15 knots when spoilers are unavailable.

2.62 After touchdown normal procedure should be used except that;

1. Raise the flaps to further reduce wing lift.
2. Use wheel brakes as necessary, but do not skid the tyres.
3. Below 60 KIAS, nose-wheel steering may be used for directional control.

WARNING

Ensure that rudder is centred prior to engagement of nose-wheel steering.

AL 8(7)

2.63 During a crosswind landing with the hydraulic flight controls disconnected, increased control stick pressures and reduced control sensitivity make the landing extremely hazardous. If the crosswind component exceeds 8 knots, it is recommended that the arrestor gear be used.

NOTE

In high crosswinds (20 to 25 KIAS), wind gusts become more prevalent. Pay close attention to lateral control, particularly when landing with asymmetric store loadings.

With any asymmetrical load, the maximum permissible crosswind component under the loaded or heavy wing is 15 knots without spoilers and 25 knots with spoilers open.

2.64 If excessive crosswind exists, apply full aileron deflection into the wind concurrent with full forward stick. Apply opposite rudder, as required, to maintain straight tracking down the runway. Braking can then be applied as described above if the wings are level. If the wings are not level, brake pedal pressure on the up-wing side should be reduced to prevent tyre blow out. External stores on the aircraft help stabilize the aircraft in crosswind conditions and allow heavier braking than for a clean configuration aircraft.

Landing On A Wet Runway/Hydroplaning

2.65 The following procedures should be used when landing on a wet runway:

1. Use of short field arrestor gear should be considered, if available.
2. Land on longest available runway that is acceptable to aircraft crosswind and arresting gear limitations.
3. Land no faster than optimum approach speed. Dump/burn down as much as practicable to reduce optimum approach speed and minimize stopping distance.
4. Make a positive touchdown as close as practicable to the threshold. Do not flare.
5. Check that spoilers deploy on touch down, and deploy the drag chute.
6. Use rudder as necessary to track straight down runway until below rudder effectiveness speed, at which time brakes and nose-wheel steering may be used.

WARNING

Less rudder deflection is required to counteract crosswind or drift with nose wheel steering engaged. Rudder pedals should be centralized as the nose-wheel steering is engaged to prevent excessive swerving or loss of control.

NOTE

Nose-wheel steering must be used judiciously to prevent nose-wheel skidding.

7. Due to the decreased friction-coefficient, braking technique must be modified to prevent locking the wheels, which further decreases braking effectiveness. Apply light braking. If a skid is felt, release the brakes and resume light braking when the track straightens out.
8. If abort gear is not available and there is doubt that the aircraft can be stopped on the runway, either:
 - a. Go around if adequate runway remains or,
 - b. Secure the engine as airspeed decreases below 80 KIAS, with the aircraft under control.
9. Be prepared to drop the hook and take the abort gear, if necessary.

Aerodynamic Braking

2.66 When a drag chute is not available it is possible to reduce the landing roll without heavy use of brakes by utilising the high induced drag of the modified delta wing. Make a normal approach and touchdown but after the nose-wheel has touched, trim full nose up and apply back-pressure to raise the nose to a 10 degree nose up attitude. Maintain wings level. At approximately 100 KIAS allow the nose to fall through and commence braking as necessary to bring the aircraft to taxi speed.

CAUTION

If the nose is raised too high, the drop tank tails may touch the runway.

If landing distance is critical, follow the minimum distance procedures.

AL 8(7)

Landing On An Ice-covered Runway

2.67 If it is not feasible to divert to a field with better landing conditions, use the following techniques:

1. Carry out a short field arrest if possible.

2.68 If unable to make a short field arrest:

1. Land no faster than optimum approach speed. Burn/dump fuel to reduce optimum approach speed and minimize stopping distance.
2. Touch down so as to utilize all available runway.
3. Make a positive touchdown. Do not flare.
4. Check that the spoilers deploy on touchdown, and deploy the drag chute.
5. Use rudder as necessary to track straight down the runway until below rudder effectiveness speed, at which time nose-wheel steering may be used.

NOTE

Nose-wheel steering must be used judiciously to prevent the nose-wheel from skidding. In severe ice conditions, the nose-wheel steering may not be effective.

6. Because of the decreased friction coefficient, braking technique must be modified to prevent wheel locking, which further decreases braking effectiveness. Apply light braking evenly and cautiously. If a skid is felt, release the brakes and

resume light braking when the track straightens out.

7. If abort gear is not available and there is any doubt as to being able to stop on the runway, secure the engine as the airspeed decreases below 80 KIAS if the aircraft is under control directionally. If directional control problems exist, go around provided adequate runway remains.
8. If airspeed is not down to a safe taxi speed prior to reaching the abort gear, be prepared to drop the hook.

2.69 The above procedures may be modified as necessary to allow for conditions of less severity than a completely ice-covered runway.

Landing at High Gross Weights

2.70 Occasionally the problem will arise of landing at a gross weight in excess of the recommended maximum, due to emergencies, fuel problems, etc. The problem with landing at high gross weight is one of stopping since the sink speed at touchdown can be minimized by utilising a shallower, higher power approach. Stopping distance may be reduced by increasing braking, securing the engine, and/or using the arrestor gear.

2.71 A flat approach using optimum angle of attack should be maintained to avoid high rates of descent and excessive airspeed. Final approach speed is critical and, once the runway is definitely made, power and attitude should be adjusted to touch down with a minimum rate of descent.

POST FLIGHT

AFTER LANDING

2.72 After landing carry out the following procedures:

1. Horizontal
Stabilizer SET 1 DEG NOSE UP

NOTE

This setting will prevent rain from entering the internal structure of the aircraft.

2. KY-58 ZEROISE, OFF
3. Role Equipment OFF
4. AFCS OFF
5. Drop Tank Pressurization OFF

6. Flaps UP
7. Speedbrakes IN
8. Radar OFF
9. ADI CAGE
10. Oil Quantity 80% CHECK
11. Radar Altimeter OFF
12. RWS OFF
13. Audio Panel VOR/ILS OFF
14. IFF OFF
15. TACAN OFF
16. AVTR OFF, OBSERVE RUN
LIGHT EXTINGUISHES

The RUN light extinguishing will show that the video tape has unthreaded.

17. Strobe Light OFF

The Strobe Light is an eye hazard within one metre.

18. Anti-Icing OFF
19. Cabin Temperature MANUAL HOT
20. Windshield Defrost (A-4) INCREASE
21. Taxi Light OFF

22. Canopy Rifle Bolt (TA-4) ... UNLATCHED
23. Headknocker DOWN
24. G Suit Valve CLEAR MOISTURE

Clear air conditioning system of condensation after each flight by turning the temperature control to full hot and depressing the anti-g suit valve until warm air is expelled or for a period of one minute.

25. Spoilers DE-ARM ENTERING LINE

If wind strength exceeds 35 kts, spoilers should be left up until the aircraft is chained down.

For engine cooling purposes, whenever the engine has been operated above approximately 85% for a period exceeding one minute, the engine should be operated at idle for a period of at least three minutes, just prior to shutdown.

1. Chocks IN
2. INU PERFORM SHUTDOWN
(If applicable)
3. DTM UNLOAD
4. HUD OFF
5. Display Units OFF
6. Audio Panel ARC 182 OFF

Removal of aircraft power with the ARC 182 ON may result in damage to the radio.

7. NAS OFF

If the engine has been operating at IDLE for longer than five minutes, RPM should be increased to 70% for 30 seconds. After re-stabilising RPM at idle, the engine can then be shut down.

- | | | |
|-----|---|------------------------------------|
| 8. | With engine stabilized
at IDLE, Throttle | OFF AFTER
GROUND CREW
SIGNAL |
| 9. | ARC 159 | OFF |
| 10. | Rotating Beacon | OFF |
| 11. | Canopy (TA-4) | UP AT 35% |

Do not commence opening canopy (ambient cockpit temperature permitting) until engine is below 40 percent rpm. Above 40 percent, loose equipment lost inadvertently from the cockpit area will likely be ingested by the engine.

12. DTM REMOVE
13. SVM REMOVE

AL 10(8)

SPECIAL GROUND PROCEDURES

Hot Weather Operations

2.73 When the OAT >28°C, the following amendments to the normal check-list procedures are to be followed:

1. NAS ON 8 MIN PRIOR TO TAXI
2. Radar OFF UNTIL ABOVE 5,000 FT
UNLESS CRITICAL FOR
RADAR TRAIL DEPARTURE
3. ARC-182 OFF (IF ON GND FOR
LONG PERIOD)

Hero Procedures

2.74 When HERO conditions apply, the following precautions must be complied with from start-up until immediately prior to take-off:

1. Radar OFF or STANDBY
2. UHF/VHF Transmissions NIL DURING
ARM/DE-ARM

3. TACAN REC ONLY

4. Radar Altimeter OFF

5. IFF STANDBY

2.75 For aircraft arming, immediately prior to arming:

6. NAS Master Mode NAV

7. Master Arm OFF

8. CDS OFF

Carport Operations

2.76 For operations when using carports, the headknocker is *not* to be raised until clear of the carport area.

Engine Oil System

2.76a If the engine has been operated at idle for longer than five minutes, at any time, the rpm should be increased to 70% for 30 seconds to ensure adequate scavenging of the engine oil system.

HOT REFUELLING PROCEDURES

2.77 The following procedures are to be used when refuelling aircraft with the engine running.

WARNING

Aircraft with loaded CDS are to be de-armed in an authorised area before taxiing to the hot refuel point.

NOTE

Hot refuelling is to be carried out through the refuelling probe only.

Prior To Entering the Refuelling Area

1. All ancillary Electrical Equipment
(Except Radios) OFF
2. Anti-Collision Beacon OFF
3. Canopy CLOSED
4. Cabin Pressurization RAM
5. Air Refuel switch NORMAL

6. Drop Tank Pressurization OFF

At The Refuelling Area

1. Checks Complete THUMBS UP TO
GROUND CREW
2. Allow groundcrew to engage hose and commence refuelling. Once groundcrew have checked the Primary/Secondary switch, monitor fuel transfer.

NOTE

Do not select the drop tank pressurization switch to AIR REFUEL (A-4), or FLIGHT REFUEL (TA-4) until the internal fuel gauge indicates the tanks are refuelling. This allows the ground crew time to carry out their PRIMARY/SECONDARY checks.

3. The position of the drop tank pressurization and air refuel switches will depend on the fuel load required, as follows.
 - a. Internal tanks only;
 1. Drop tank pressurization OFF
 2. Air Refuel switch NORMAL

AL 8(7)

b. Full internal and full drop tanks or full internal and partial centreline drop tank;

1. Drop tank
pressurization ... AIR REFUEL (A-4)
FLIGHT REFUEL (TA-4)
2. Air Refuel switch NORMAL

c. Equivalent of full internal and partial drop tanks when drop tanks are located on stations 2 and 4;

1. Drop tank
pressurization ... AIR REFUEL (A-4)
FLIGHT REFUEL (TA-4)
 2. Air Refuel switch FUSE ONLY
- Fill drop tanks to maximum capacity then:
3. Drop tank pressurization OFF
 4. Air Refuel switch NORMAL

d. Allow the internal tanks to fill to the quantity required.

CAUTION

Do not partially fill drop tanks when located on stations 2 and 4 as there is no way of ensuring that each tank has an equal quantity of fuel.

During Refuelling

1. Fuel Contents MONITOR
2. Drop Tank Pressurization
and Air Refuel Switch AS REQUIRED
TO OBTAIN
DESIRED
FUEL STATE

WARNING

Be alert for signs of fire.

When Refuelling Complete

1. Refuelling Complete THUMBS UP

NOTE

If the refuelling crew stop the refuel at a pre-briefed amount, a thumbs up will be given to the pilot. If contents are correct give a cut signal. If not correct give a thumbs down and relay problem either by intercom or writing on kneeboard.

2. After Start Checks COMPLETE
 3. Cabin Pressurization NORMAL
 4. Anti-Collision Beacon ON
- 2.78 In conjunction with the groundcrew:
5. Flaps SET HALF
 6. Horizontal Stabilizer . SET FOR TAKE OFF
 7. Aileron Trim SET FOR TAKE OFF
 8. Sniff Check COMPLETE
 9. Drop Tanks DEPRESSURIZE
(5 FINGER CHECK)
 10. Chocks REMOVE

Emergency Stop

1. Anti-Collision Beacon ON
2. Indicate Cut Signal HAND ACROSS
THROAT
3. Relay with groundcrew intercom and/or radio if appropriate.

AIR TO AIR REFUELLING PROCEDURES

NORMAL OPERATION

Refer Figure 2-7.

Before Take-off

1. Ship-tank switch OFF
2. Drogue position switch RET
3. Refuelling master switch OFF
4. Fuel transfer switch OFF
5. Light switch BRT (DAY);
DIM (NIGHT)
6. Gallons delivered
indicator set to 000

7. Hose jettison switch. OFF
(FORWARD)
8. Ship-tank switch FROM STORE
9. Dump light TEST

NOTE

If there is fuel in the store, the light should come on. If there is no fuel in the store, press-to-test the light to ensure that bulb is good.

10. Ship-tank switch OFF

AL 8(7)

Drogue Extension

1. Refuelling master switch ON
2. Drogue switch EXT

NOTE

Be prepared for small trim changes as the drogue is extended.

3. Drogue position will read EXT, WHEN
DROGUE
REACHES FULL
TRAIL POSITION
4. Ship-tank switch TO STORE, (FOR
OVER 300
GALLON
TRANSFER)

CAUTION

When TO STORE is selected, the pressurised wing tank limits are to be observed.

NOTE

Do not select Ship-tank Switch **TO STORE** until 50 gallons has been transferred from the store, to prevent over pressurizing the wing tank.

Engagement And Transfer

2.79 When the amber light on the tanker refuelling store is on, the aircraft to be fuelled manoeuvres into position for probe-drogue engagement. After the probe is engaged in the drogue, the receiving aircraft must move forward (4 to 6 feet in relation to the tanker) until the store amber light goes off. As long as the two aircraft maintain this relationship, fuel transfer may be made with the fuel transfer switch in TRANS. Actual refuelling will be indicated by the green light on the store coming on. Fuel flow through the probe to the wing and fuselage tanks is automatic.

2.80 If the drop tanks are to be fuelled, the drop tanks switch must be positioned to FLIGHT REFUEL. Fuel flow will then be through the probe to the drop tanks, wing tank and fuselage tank simultaneously.

CAUTION

*On all receiver aircraft that are fitted with an Air Refuelling Store Control Panel, ensure that the SHIP-TANK switch is in the **OFF** position before commencing air refuelling.*

*Ensure that the EMERGENCY WING TANK TRANSFER switch is in the **OFF** position before commencing air refuelling.*

Stopping Fuel Transfer

2.81 To halt fuel transfer to the receiver at any time, place the fuel transfer switch in **OFF** position.

NOTE

Refuelling cannot be stopped by placing the refuelling master switch in the **OFF** position. Refuelling will stop if the receiver aircraft backs off enough for the amber light to come on or if the probe disengages. In either case, the drogue position indicator window will change from TRA to EXT.

2.82 To halt fuel transfer to the store, turn SHIP-TANK switch to **OFF**.

Drogue Retraction

1. Fuel transfer switch. OFF
2. Airspeed 250 KIAS OR LESS
3. Drogue switch RET

NOTE

If the drogue cannot be fully retracted at 250 KIAS, reducing airspeed to 230 KIAS or less should permit full retraction.

4. When drogue position indicator reads RET, place the refuelling master switch to **OFF**.

NOTE

The refuelling master switch may be moved to **OFF** at any time after the drogue has extended. In this case the tanker store propeller will feather automatically only after the drogue has returned to the retracted position.

AL 8(7)

Transfer From Store To Wing

2.83 If it is desired to transfer fuel from the refuelling store to the wing tank, place the SHIP-TANK switch to **FROM STORE**. This will cause both drop tank air shut-off valves and the refuelling store shut-off valve to open, allowing all external tanks to be air pressurized by the engine. Fuel will then flow from the drop tanks and the refuelling store to the wing tank. Transfer of fuel from the store to the wing tank is very slow but will transfer fuel at approximately the rate that fuel is burned unless high power settings are used. While fuel is flowing from the store to the wing, the dump light will be on.

NOTE

If transfer of fuel from the drop tanks cannot be stopped by placing the drop tank pressurization switch on the engine control panel to **OFF**, check to see that the ship tank switch on the air refuelling control panel is in the **OFF** position. If this switch is in the **FROM STORE** position, transfer from the drop tanks and refuelling store is automatic and pressurization will be continuous unless the ship tank switch is placed to **OFF**.

Dumping Fuel

2.84 An electrically operated fuel dump valve is located on the bottom of the refuelling store. To dump fuel, first

depress the spring-loaded lever guard assembly, then raise the master switch from the spring-loaded safety position and position at **DUMP**. While fuel is actually dumping, the dump light will be on.

CAUTION

On rare occasions, fuel dumped from the store may re-enter and accumulate in the aft section of the store and may create a fire hazard if the store is operated after dumping.

Before Landing

1. Ship-tank switch. OFF
2. Drogue switch RET
3. Drogue position indicator RET
4. Refuelling master switch OFF
5. Fuel transfer switch OFF
6. Drop tanks switch OFF

NOTE

If practicable, open store dump valve prior to any arrested landing to ensure the store is empty. Ensure dump valve is closed prior to landing.

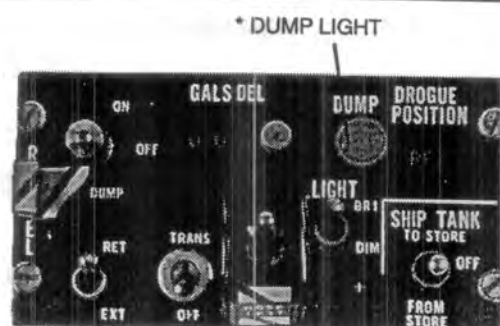
AL 7(0)

TANKER PANEL CONFIGURATION PRIOR TO REFUELLING



NO LIGHT

* BY ACCESSORY CHANGE NO. 1



REFUELLING MASTER SWITCH OFF
 FUEL COUNTER 000
 DROGUE POSITION INDICATOR RET
 DROGUE POSITION SWITCH RET
 TRANSFER SWITCH OFF
 HOSE JETTISON SWITCH . (OFF = FORWARD)
 LIGHT SWITCH (DAYTIME) BRT
 SHIP TANK SWITCH OFF



DROGUE EXTENDED - NOT ENGAGED



AMBER LIGHT

REFUELLING MASTER SWITCH ON
 DROGUE POSITION SWITCH EXT
 DROGUE POSITION INDICATOR EXT

NOTE
 ON POSITION OF REFUELLING MASTER
 SWITCH UNFEATHERS RAM AIR TURBINE
 FOR STORES HYDRAULIC PRESSURE.

ENGAGED - BEFORE FUEL TRANSFER



NOTE
 COUPLING OF PROBE WITH DROGUE
 WHILE TRANSFER SWITCH IS OFF
 CAUSES DROGUE POSITION INDICATOR
 TO SHOW (TRA) MEANING READY TO
 TRANSFER.



DROGUE POSITION INDICATOR TRA



FUEL TRANSFER



GREEN LIGHT

TRANSFER SWITCH TRANS
 FUEL COUNTER (COUNTS GALLONS)

NOTE
 GALLONS COUNTER CONFIRMS FUEL
 TRANSFER TO TANKER PILOT. GREEN
 LIGHT CONFIRMS FUEL TRANSFER TO
 RECEIVER PILOT.

Figure 2-7 Tanker Operation — Air Refuelling (Sheet 1 of 2)

AL 7(0)

DISENGAGEMENT

REFUELLING MASTER SWITCH ON
TRANSFER SWITCH OFF
DROGUE POSITION INDICATOR EXT

DROGUE RETRACT

REFUELLING MASTER SWITCH ON
DROGUE POSITION SWITCH RET
DROGUE POSITION INDICATOR RET

NO LIGHT

AFTER DROGUE RETRACT
REFUELLING MASTER SWITCH OFF

FUEL DUMP

NOTE
FUEL DUMPING SHOULD ALWAYS BE
DONE PRIOR TO ANY ARRESTED
LANDING EITHER AFLOAT OR ASHORE

* BY ACCESSORY CHANGE NO. 1

* DUMP LIGHT

REFUELLING MASTER SWITCH DUMP
(ALL OTHER SWITCHES SAME AS NORMAL
PANEL CONFIGURATION)

HOSE AND DROGUE JETTISON - EMERGENCY

NOTE
5 TO 20 SECOND TIME DELAY
IS A SAFETY FEATURE

WARNING

DO NOT MOVE HOSE JETTISON
SWITCH FROM HOSE JETTISON
POSITION AFTER JETTISONING.

HOSE JETTISON SWITCH ... HOSE JETTISON
TRANSFER SWITCH OFF
REFUELLING MASTER SWITCH . (CONDITION)
DROGUE POSITION SWITCH ... (CONDITION)
DROGUE POSITION INDICATOR EXT

NOTE
JETTISONING CUTS OFF ALL
STORE POWER EXCEPT POWER
TO SHIP TANK SWITCH AND TO
DUMP FUEL. THEREFORE, FUEL
DUMP IS POSSIBLE AFTER
JETTISONING.

Figure 2-7 Tanker Operation — Air Refuelling (Sheet 2 of 2)

AL 8(7)

JETTISONING THE FUELLING STORE

2.85 The air refuelling store may be jettisoned electrically in the same manner as other droppable external stores. (Refer to Chapter 8, Weapons Systems.)

EMERGENCY OPERATION

2.86 Refer to Chapter 5, Emergency Procedures.

TANKER SAFETY PRECAUTIONS

2.87 The following safety precautions must be observed:

1. Do not start the turbine or extend or retract the drogue when over populated areas or when other aircraft are close abeam or astern.
2. Do not extend the drogue after it has been retracted when a hydraulic leak has been observed.
3. Do not extend the drogue if there is any evidence of a possible electrical failure.
4. Do not energize the turbine after dumping fuel unless failure to provide fuel will place another aircraft in jeopardy.
5. Do not actuate the speedbrakes during any part of the refuelling operation.
6. Once the hose jettison switch is actuated to its **HOSE JETTISON** position for emergency jettisoning in flight, do not move back to **OFF**. Inadvertent cycling of this switch will cause internal damage to the store and may create a fire hazard.

CAUTION

*Be sure that the ship-tank switch is **OFF** during arrested landings. The integral wing tank pressure increases to 6 psi above ambient when the ship-tank switch is in the **TO STORE** position. The addition of the 6 psi static pressure to the accelerations induced by arresting would impose severe loads on the tank surfaces.*

*When the ship-tank switch is in the **TO STORE** position, overpressurization of the wing tank is possible if fuel covers the fuel vent outlet in the tank. This condition will exist during negative-g operation, and when the aircraft is in a nosedown attitude. Refer to Wing Tank Pressurized Limits in Chapter 4.*

STORE LIMITS

2.88 Refer to Chapter 4 for Store Operating Limitations.

PILOT TECHNIQUE

2.89 Air refuelling engagements can be accomplished at any altitude within a wide range of airspeeds. The optimum airspeed for engagement is approximately 230 KIAS. Use of optimum airspeed will assist the receiver in escaping heavy buffeting caused by the tanker slipstream and jet exhaust.

2.90 Closure rates above 5 knots may induce hose whip. If hose whipping or kinking occurs during normal receiving hookup, disengagement should be made immediately and the store inspected for hose tension regulator malfunction.

2.91 Thermal turbulence from the ground may be annoying for hookups at very low altitudes due to oscillatory drogue motion.

2.92 The receiver should start the engagement approach from behind and below the tanker. The receiver's flight path prior to engagement should follow the angle of the trailing drogue hose, using the drogue as a target reference only during the final 3 or 4 feet prior to contact. The best reference for line-up has been found to be the inboard edge of the tanker aircraft's left gear door fairing. The receiver pilot will notice increased pitch sensitivity at this point. A slight throttle advance may be necessary to maintain a definite closing rate during the final 3 feet. To facilitate engagement at night, an air refuelling probe light is mounted in the outboard leading edge of the right engine intake and is controlled by a switch located on the wedge outboard of the right-hand console.

2.93 After engaging, the receiver aircraft must move forward so that a minimum of 4 feet of hose take-up occurs, starting the fuel transfer. The store hose is striped each two feet for the last 20 feet to be unreeled. The receiver refers to these stripes to assist in maintaining a stable distance from the tanker during refuelling. It is never necessary to close to a point where the stripes are not visible.

2.94 The receiver should be flown so that the hose is centred laterally and maintained just above the lower centreline lip of the store's trailing edge, but not riding on or touching the lower lip. This optimum position is approximately 2 feet below the drogue's normal trailing position. This position is the most comfortable position for the receiver to avoid severe buffeting. Once the engagement has been accomplished, it is not difficult to fly the receiver dead astern with a 2 foot lateral tolerance, even in rough air or when turning.

AL 8(7)

2.95 Mild buffeting will be felt by the receiver, but it should not be uncomfortable. Occasional mild fuel sprays of short duration may hit the receiver, but the only adverse result is possibly a greasy film on the windshield. Disconnecting is accomplished by the tanker holding constant power while the receiver retards throttle. The hose reel will unwind the takeup until it reaches the end of the hose travel and the receiver will break free.

WARNING

When receiving fuel from a KC-135 aircraft, the maximum total fuel on board the receiver shall not exceed 4500 pounds of JP-4 or 4750 pounds of JP-5. Failure to observe these limitations may result in overpressurization and rupture of the fuel tanks due to inadequate pressure regulation of KC-135 aircraft tanker systems.

Do not engage, or remain engaged to, a steadily leaking drogue. The leaking fuel will be ingested into the engine and may ignite and explode. The small amount of fuel that is leaking momentarily during plug in and disengagement is not considered dangerous.

FLIGHT PROCEDURES REFUELLING TRAINING

2.96 Refuelling training should be accomplished at various altitudes in accordance with current Standard Operating Procedures.

Prior To Refuelling

2.97 After rendezvous has been effected, the Flight Leader of the receiver aircraft will position his flight in loose line abeam to the tanker on the side opposite the tanker escort, if assigned. The Flight leader will then pass the lead to the tanker pilot if applicable.

2.98 The Flight Leader's position will be abeam the tanker with at least 200 feet separation in case a store turbine blade flies off during unfeathering.

2.99 When the flight is in position, the leader of the receiver aircraft will signal the tanker to unfeather (1-finger turn-up signal).

2.100 The tanker will unfeather, ensuring airspeed is 300 KIAS or less.

2.101 The Flight Leader will indicate by a "thumbs-up" or "down" whether or not the turbine unfeathered. If the turbine does not unfeather, the tanker will secure store and not make further attempts to unfeather, unless failure to provide fuel would place receiver aircraft in jeopardy.

2.102 If the turbine unfeathers on the first attempt, the tanker responds to the "thumbs-up" signal of the Flight Leader by extending the drogue.

2.103 When the drogue has extended, the flight leader (or escort) should indicate successful extension with a thumbs up. The tanker pilot will then clear each aircraft onto the drogue in turn. Drogue extension will slow tanker speed. The tanker should adjust power to maintain desired refuelling speed. 230 KIAS is recommended; however, plug-ins may be made anywhere in the store operational envelope of 200 to 300 KIAS. If drogue extension is not snubbed as it approaches the fully extended position, do not attempt plug-ins.

2.104 The tanker pilot, as leader of the refuelling formation, has the primary responsibility for maintaining a good lookout for other aircraft, although other members of the flight are responsible for assisting to the maximum extent possible.

2.105 Any evidence of a hydraulic leak from the buddy store during refuelling operations should immediately be reported to the tanker pilot and the store secured.

2.106 Do not turn pressurization to RAM while in flight refuelling. Eyeball diffusers shall be turned away from pilot's face. If fuel is injected into the engine from a leaking drogue, it may appear in the cockpit as white smoke. Immediately disengage if smoke appears in the cockpit.

AL 8(7)

Refuelling

2.107 The leader should detach and move into a position 20 feet behind and below the drogue, on a plane with the trailing hose, to minimize turbulence from the tanker's wake. Call "lining up," before sliding into position behind the tanker. Observe amber light on tanker store, indicating store may be engaged. If light is not on, use caution during engagement, as hose tensioning and reel-in may be inoperative. The most likely cause, however, is a burned-out bulb. Trim the aircraft slightly nose-down to remove any slop from the elevator control system, and move forward and up the hose reference until the tip of the probe is 5 to 10 feet directly behind the drogue. Pause here long enough to get stabilized, then add enough power to close and engage the drogue at a closure speed of about 3 knots. Either the tanker or the probe and drogue may be used as the primary visual reference, however, both must be perceived to make consistent and safe engagements. Closing speeds in excess of 5 knots may cause hose-whip, with ensuing damage to probe, hose and drogue, or both. Also, if misaligned at high closure speeds, damage to radome, nose section, pitot tube, or canopy may occur. If the drogue is missed, stay below the drogue and back straight out until the drogue is in sight. Avoid looking up too high for the drogue as the pilot may unconsciously pull back on the stick and climb into the drogue. Instead, use the tanker as a reference until safely aft of the drogue.

2.108 After engaging the drogue, continue to push in the hose until the amber light is out, and then call "____, contact". The last 20 feet of hose to unreel from the store has a white stripe every 2 feet. At least two stripes must be pushed into the store before the transfer will occur. Do not fly so close that no stripes are visible. Maintain a position so that if some opening between the tanker and the receiver occurs, the transfer will not be interrupted. This position should also be along the general reference of the hose before plug-in and will keep the hose centred slightly above the lip of the aft end of the store.

CAUTION

To preclude possible engine flameout and/or explosion, the following procedures should be used during receiver hookup. After the receiver pilot has made hookup, the tanker pilot will place the transfer switch momentarily to the transfer position for a maximum of 1 second (transferring 2 to 3 gallons) to test for proper probe/drogue coupling. If no transmissions are heard from the receiver or the receiver does not disengage, reinitiate transfer. Excessive fuel on the windscreen, smoke or mist in the cockpit, and rising EGT are indications of possible impending engine explosion due to

fuel ingestion in the engine intakes. If excessive fuel leakage is noted, the receiver pilot should notify the tanker operator immediately, retard throttle to idle and disengage from tanker. If the IFR probe valve continues to leak excessive fuel after disengagement, full right rudder should be applied until the valve has fully closed. This will tend to cause the fuel to flow out-board of the engine intake ducts. Do not attempt further plug-ins unless low fuel state so dictates. Inspect the probe and drogue for malfunction after landing.

CAUTION

If the amber light on the Buddy Store illuminates after engagement (i.e. the receiving aircraft has drifted out of the transfer position) the air refueling hose may uncouple from the drogue. The receiving aircraft is to disengage and re-engage to prevent possible fuel leakage from the drogue.

2.109 Breakaway is accomplished by the receiver reducing power in order to open from the tanker at about 3 knots. Back straightaway and down, following the line of the trailing hose. Stay behind the drogue until all members of the flight are sighted. To facilitate this, it is necessary that all members of the flight properly maintain their position in line abeam. When the receiver aircraft is clear of the area behind the hose and drogue, call "____, clear".

2.110 After disengaging, the leader will move to the opposite side of the tanker, where he will supervise the refuelling, giving help as necessary. After the leader is clear of the drogue, the No. 2 aircraft will be cleared to move into position and make his plug-in. He will then disengage and join the leader in loose, outside line abeam, as before. Each member in turn will make plug-ins and upon completion will move to the next position on the leader.

2.111 Refuelling can be carried out 'no comm' if briefed. The store controller will show the tanker pilot when the receiver has made contact, is ready for transfer, and has backed off.

After Refuelling

2.112 When all members of the flight have successfully completed refuelling and are clear of the drogue, the Flight Leader will signal to secure the store. The tanker pilot will retract the drogue and feather the air turbine. The Flight Leader will indicate that the drogue has retracted and the turbine is feathered by giving a "thumbs-up" signal.

AL 8(7)

2.113 Upon completion of refuelling, the Flight Leader should resume lead of his flight, breaking away from the tanker in an easy turn until well clear. The tanker maintains straight and level flight until adequate separation from the receiver aircraft is assured. To ensure safe separation, an altitude differential should be maintained.

MISSION REFUELLING

2.114 The range and fuel specifics for mission refuelling are covered in Chapter 9 and in the A/TA-4 Tactical Manual (NAVAIR 01-40AV-1T (A)).

CHAPTER 3

FLIGHT CHARACTERISTICS

	PAGE		PAGE
INTRODUCTION	3-1	Adverse Yaw	3-14
FLIGHT CONTROLS	3-1	High Angle-Of-Attack Pitch Up	3-14
AILERONS	3-1	Normal Stalls	3-14
ELEVATORS	3-1	Accelerated Stalls	3-15
RUDDER	3-4	Stall Recovery	3-15
TRIM	3-4	NOSE-HIGH, LOW	
SLATS	3-4	AIRSPPEED CHARACTERISTICS	3-15
WING FLAPS AND LANDING GEAR	3-4	OUT OF CONTROL FLIGHT	3-15
SPEEDBRAKES	3-4	INTRODUCTION	3-15
TAKEOFF AND LANDING		Departure (Post-Stall Gyration)	3-15
CHARACTERISTICS	3-4	Incipient Spins	3-15
TAKEOFF	3-4	Steady State Spin	3-15
LANDING	3-4	DEPARTURE	3-17
DIRECTIONAL CONTROL	3-4	SPINS	3-17
LEVEL FLIGHT CHARACTERISTICS	3-5	General	3-17
SLOW FLIGHT	3-5	Upright Spin Characteristics	3-17
CRUISING	3-5	Inverted Spin Characteristics	3-17
TRANSONIC MACH CHARACTERISTICS	3-5	SLAT OPERATING CHARACTERISTICS	3-18
GENERAL	3-5	NORMAL OPERATIONS	3-18
TRANSONIC PITCH UP	3-5	ASYMMETRIC SLAT CHARACTERISTICS	3-18
TRANSONIC MANOEUVRING	3-5	Poor Slat Modulation	3-18
DIVING	3-8	Slat Locked Out	3-18
FLIGHT WITH POWER		Slat Locked In	3-18
CONTROL DISCONNECTED	3-8	AERODYNAMIC LOCKOUT	3-18
FLIGHT WITH EXTERNAL STORES	3-9	FLIGHT CHARACTERISTICS ON AFCS	3-19
GENERAL	3-9	INTRODUCTION	3-19
ASYMMETRIC LOADINGS	3-9	WING DOWN PHENOMENA ON	
CG MOVEMENT	3-9	HEADING HOLD	3-19
MANOEUVRING FLIGHT	3-10	ROLLBACK ON ROLL ATTITUDE HOLD	3-19
ANGLE OF ATTACK RELATIONSHIP	3-10	CONTROL STICK STEERING FEEL	3-19
AVAILABLE MANOEUVRABILITY	3-12	Pitch	3-19
ROLL CHARACTERISTICS	3-14	Roll	3-19
Aileron Rolls	3-14	Yaw	3-19
Positive Rolling G	3-14	CONTROL STICK STEERING ENGAGE	
Negative Rolling G	3-14	TRANSIENTS DURING AUTO TRIM	3-19
Directional Stability	3-14	SENSITIVE REGIONS OF	
HIGH ANGLE-OF-ATTACK		PRESELECT HEADING	3-19
CHARACTERISTICS	3-14	LONGITUDINAL STICK MOTION	
		DURING AUTOMATIC TRIM	3-19

FIGURES

FIGURE	PAGE	FIGURE	PAGE
3-1 Stick Forces	3-2	3-4 Available Manoeuvrability	3-12
3-2 Dive Recovery Chart	3-6	3-5 Stall Speeds	3-16
3-3 Angle-of-Attack Relationship	3-10		

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CHAPTER 3

FLIGHT CHARACTERISTICS

INTRODUCTION

3.1 The flight characteristics of the aircraft as described in this section are based, whenever possible, on actual flight test information. In some instances, the results of extensive wind tunnel tests and data from flight tests of similar aircraft are used. Handling characteristics of the TA-4 and

the A-4 are very similar, with the TA-4 having slightly greater longitudinal stability. The aircraft has excellent slow flying characteristics, with positive stability in the approach configuration.

FLIGHT CONTROLS

AILERONS

3.2 The powered aileron control forces are light at all subsonic speeds. In the transonic region and above, the air loads on the ailerons become large enough to require the total output of the power control system to deflect the ailerons beyond a certain point.

3.3 On manual control, the available rate of roll is markedly reduced at all speeds. Adequate lateral control can be maintained if the speed is reduced below 0.80 IMN or 300 kts. At this speed a maximum rate of roll of approximately 10 degrees per second is available at sea level increasing to 40 degrees per second at 40,000 feet.

ELEVATORS

3.4 The powered elevator provides good control at all speeds. With the elevator power control system inoperative or disconnected, elevator stick forces will be increased, but for flight at subsonic speeds, adequate control will be available. On manual control, no more than 1.8 G can be obtained with the application of 120 pounds of stick force at 0.96 IMN at any altitude. As Mach number is increased, the manoeuvrability is further reduced. At Mach numbers less than 0.85 and altitudes below 5000 feet, a load factor of 2.7 G can be attained with 120 pounds of stick force. Above 5000 feet, and below 0.85 IMN manoeuvrability is increased and is limited by buffet or accelerated stall.

AL 7(0)

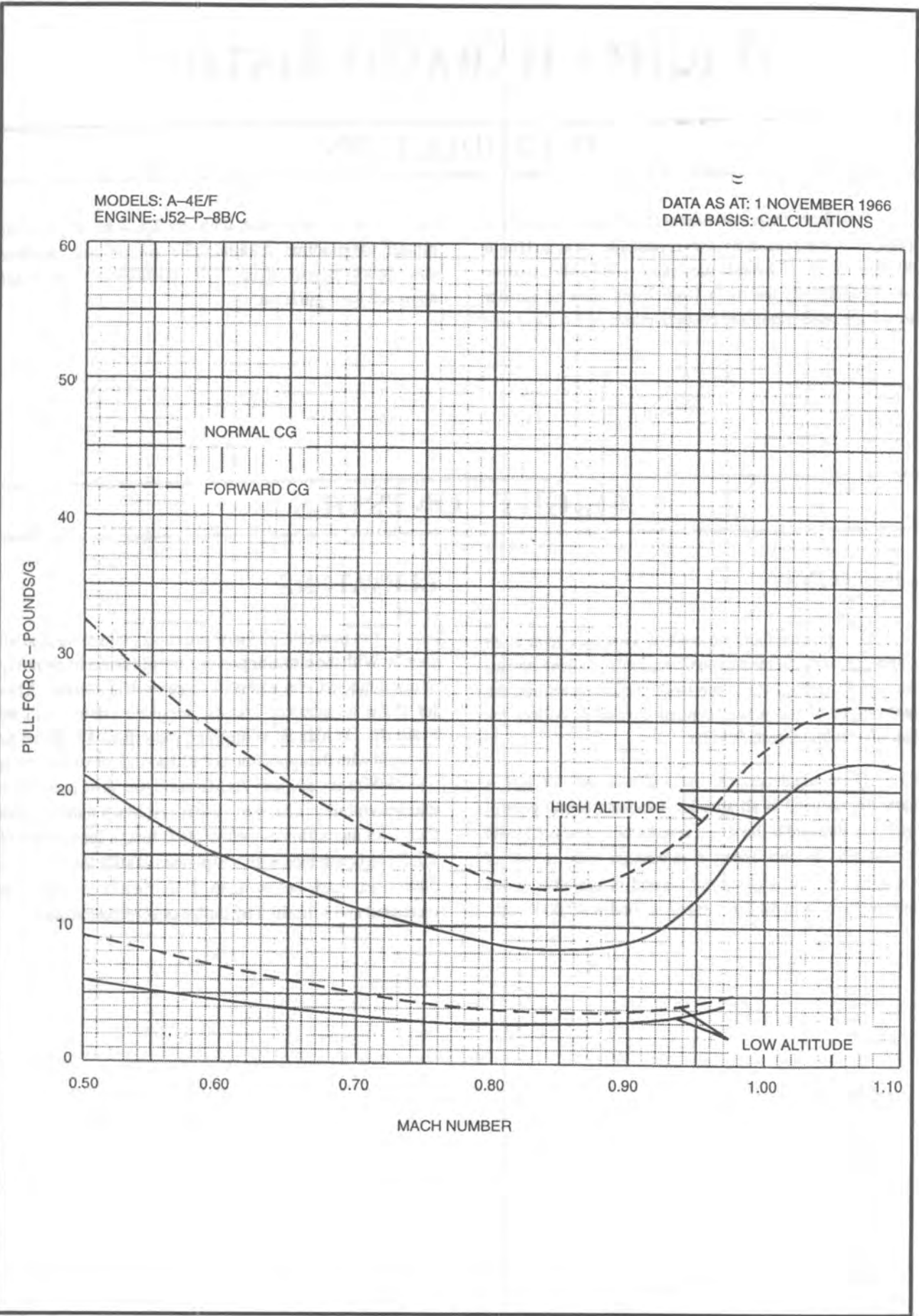


Figure 3-1 Stick Forces (Sheet 1 of 2)

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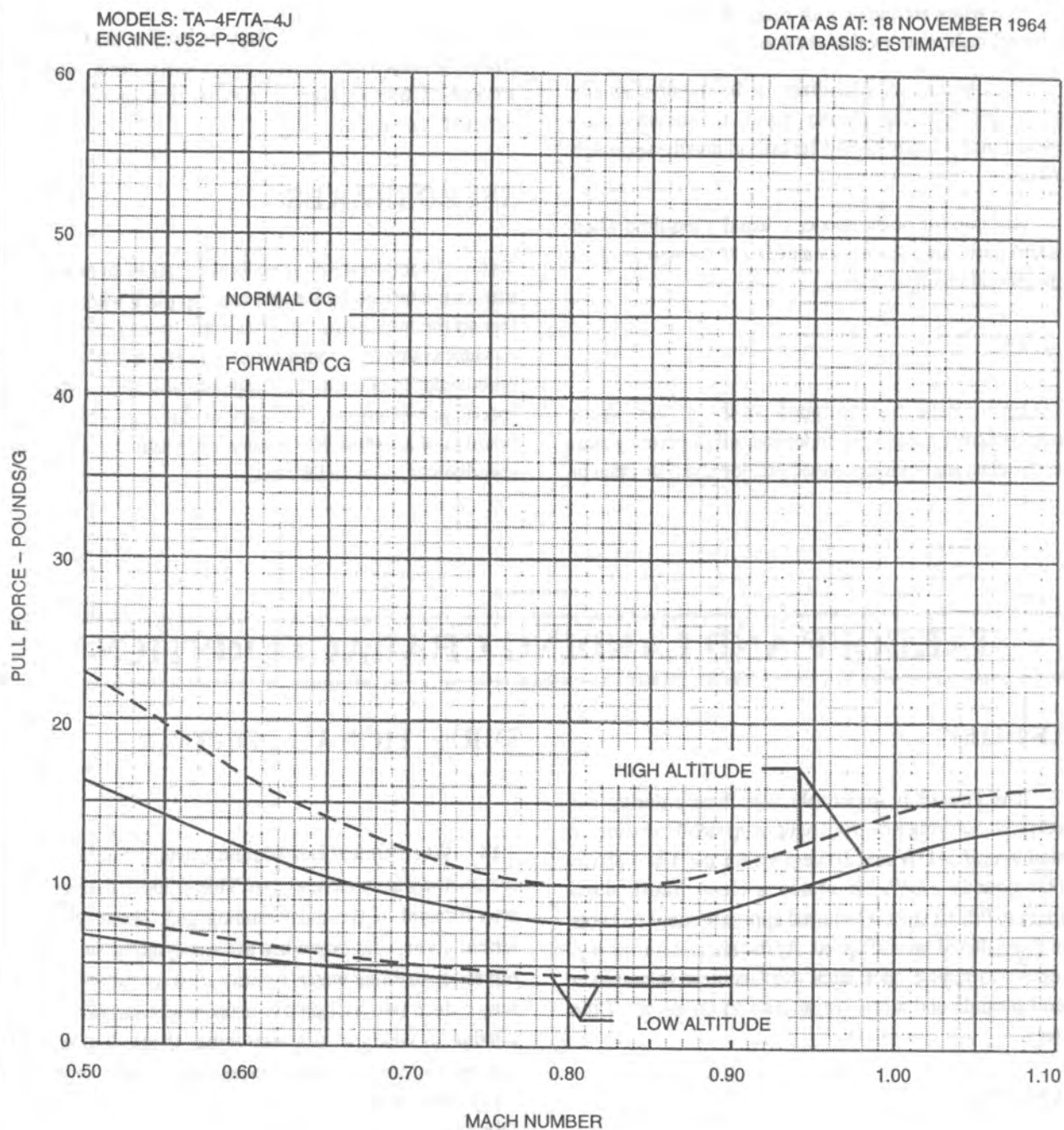


Figure 3-1 Stick Forces (Sheet 2 of 2)

RUDDER

3.5 The rudder power system provides good rudder control at all airspeeds. In the event of hydraulic failure, rudder pedal forces will increase with airspeed, but very little effort is required at approach and landing speeds.

TRIM

3.6 The trims are capable of reducing stick forces to zero for all stabilized level flight conditions.

3.7 The horizontal stabilizer will require almost constant repositioning during rapid acceleration and deceleration especially during the takeoff and the approach to landing.

3.8 Retrimming of the rudder is usually required when drop tanks are carried as minor shifting of the tanks causes asymmetrical changes in drag.

SLATS

3.9 Each wing is equipped with a 2/3 span, aerodynamically controlled, independently operating slat. Since the slats are not interconnected, one slat may open in

advance of the other causing a rolling moment away from the extended slat. Good mechanical rigging of the slat is essential for proper operation since aeroelastic effects of wing bending and twisting under high G loads could cause binding of an incorrectly adjusted slat.

WING FLAPS AND LANDING GEAR

3.10 Lowering the wing flaps or landing gear causes a slight nosedown trim change that is easily controlled. The amount of trim change is reduced if both services are selected together.

SPEEDBRAKES

3.11 Operation of the speedbrakes results in changes in trim characterized by a slight nose up pitch when opened. Due to the interconnect between the speed brake and the elevator system the control stick will move forward as the speedbrake is opened. The opposite will occur when the speedbrake is closed. The rate of this trim change is a function of airspeed. For further information on use of the speedbrakes, refer to DIVING.

TAKEOFF AND LANDING CHARACTERISTICS

TAKEOFF

3.12 The aircraft is noticeably nose heavy during the takeoff roll requiring 8 degrees of nose up stabilizer trim for normal aircraft AUW and 10 degrees for the TA-4 above 21,000 pounds AUW. To obtain a clean liftoff, three quarters to full aft stick is required approximately 10 knots prior to predicted takeoff speed. As the aircraft rotates it is necessary to reduce back stick displacement to maintain takeoff attitude and allow the aircraft to fly itself off the runway.

LANDING

3.13 Landing roll out characteristics and handling in crosswind conditions are improved with spoiler deflection. These give increased deceleration and reduce the weathercocking tendencies of the aircraft.

DIRECTIONAL CONTROL

3.14 When normal tyre friction exists, the aircraft tends to turn away from a crosswind. This is due to the large side area forward of the main landing gear about which the aircraft turns. However when the aerodynamic surfaces are effective, standing water, runway paint, or rubber deposits may reduce tyre friction to a point where the aircraft may attempt to weather cock into wind. If standing water is patchy, the aircraft may alternately turn into wind, then away from it as tyre friction decreases and increases. Directional control can be lost at surprisingly low speeds. This is particularly noticeable during a takeoff in strong or gusty crosswinds as the spoilers will be closed. The pilot must be careful to avoid excessive control inputs which may induce swerving and further aggravate the condition.

LEVEL FLIGHT CHARACTERISTICS

SLOW FLIGHT

3.15 Control is good during slow flight at approach and landing speeds; however, a lateral directional oscillation is present in rough air.

CRUISING

3.16 Level flight cruising characteristics are normal with satisfactory trim and control forces. At high altitudes and cruising airspeeds, a lateral-directional oscillation occurs in rough air. Longitudinal stability is weak to neutral at increasing aft centre of gravity positions.

TRANSONIC MACH CHARACTERISTICS

GENERAL

3.17 At airspeeds up to 0.85 Indicated Mach Number (IMN) no unusual tendencies are apparent and stick forces are low to moderate. A mild nose down trim change occurs at 0.85 IMN and increases slightly up to 0.98 IMN. At 1.02 IMN, a very slight nose up tendency appears, and increases gradually up to the maximum permissible speed. The aircraft is also sensitive to longitudinal control and trim inputs. Up to 0.90 IMN the manoeuvring stick forces are normal and control is good, but above 0.90 IMN, elevator effectiveness drops appreciably. An increase in stick deflection and therefore an increase in stick force will be required to achieve comparable load factors (Figure 3-1). Lateral directional oscillations will be more noticeable in this flight regime if stability augmentation is not engaged.

NOTE

Transonic flight should be conducted with STAB AUG engaged.

TRANSONIC PITCH UP

3.18 During accelerated recoveries from dives at supersonic speeds, a marked pitch up, proportional to existing normal load factor, will occur at approximately 0.95 IMN. After the initial abrupt increase in load factor or pitch up, the load factor will continue to build up at a slower rate as Mach number is decreased below 0.95 IMN, unless the pilot relaxes aft pressure on the stick. In the critical aft cg condition, it is possible to develop the following load factors at transonic speeds, maintaining constant stick forces as the speed reduces to 0.85 IMN without exceeding limit load factor in the ensuing pitch up:

- a. 10,000 feet 3.8g

- b. 20,000 feet 3.5g

- c. 30,000 feet 3.2g

3.19 The pitch up severity depends on the initial load factor or stick position, being most severe for full aft stick. At altitudes above 15,000 feet, and at high load factors, aircraft buffet will be encountered above 0.95 to 0.98 IMN. This buffet should be heeded as a warning. If corrective action is applied promptly, by relaxing the aft stick pressure, the pitch up can be appreciably lessened.

CAUTION

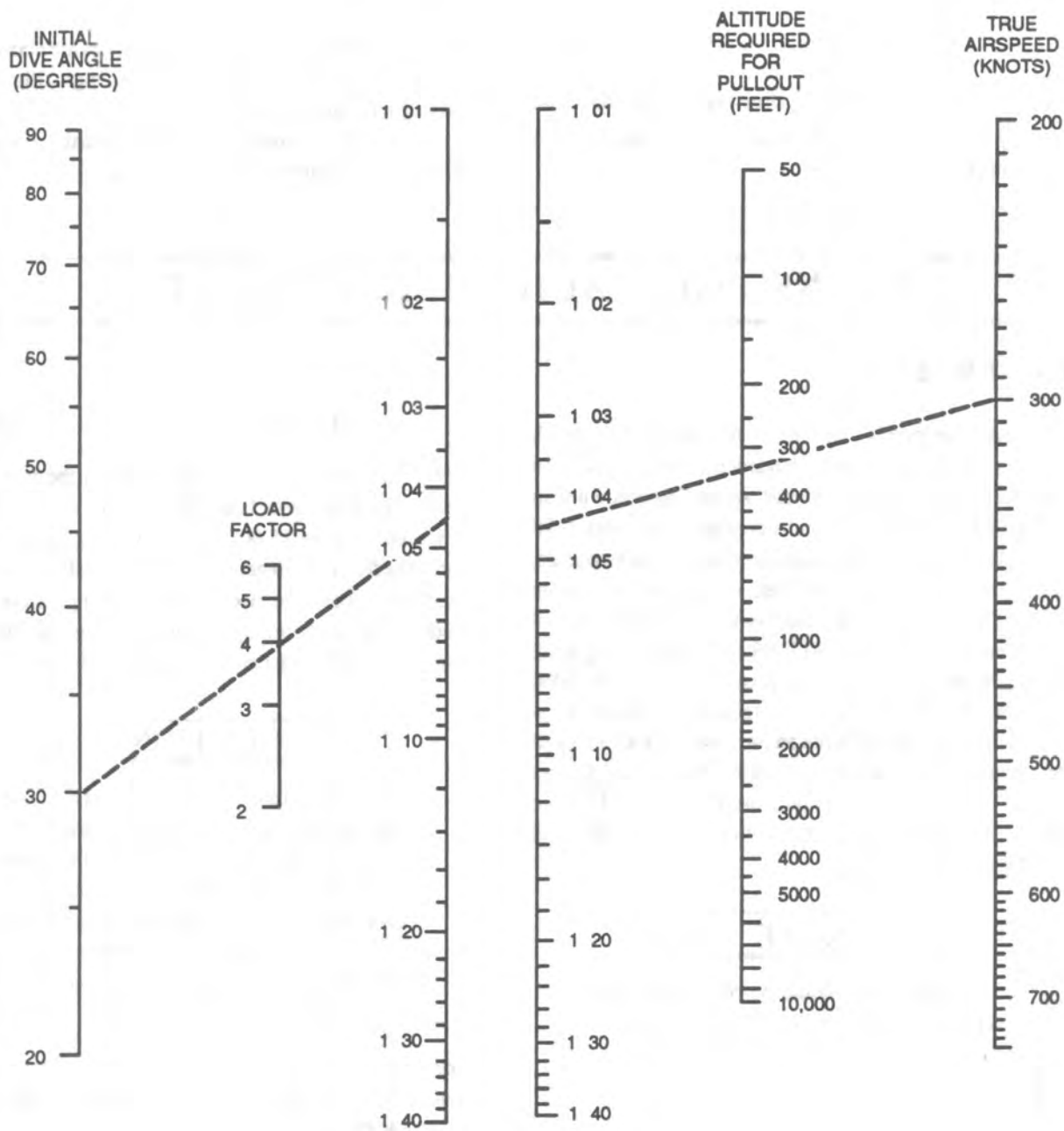
When using load factors in excess of those listed above for supersonic dive recoveries, relax aft stick pressure promptly, either upon encountering the initial sharp pitch up at about 0.95 IMN or on encountering aircraft buffet. Note that at altitudes below 15,000 feet aircraft buffet does not occur prior to pitch up.

3.20 Transonic pitch up during a speed reduction in the region where a marked increase in elevator effectiveness occurs can be appreciably decreased or eliminated entirely by reducing aft stick force as Mach reaches 0.98.

TRANSONIC MANOEUVRING

3.21 Pullouts or accelerated manoeuvres in the transonic range are characterized by abrupt random wing drop accompanied by general aircraft buffet. Large changes in bank angle may require momentary relaxation of load factor in order to level the wings and continue the pullout. The magnitude of the wing drop and intensity of the buffeting is generally proportional to the load factor developed.

DIVE RECOVERY ALTITUDE LOSS DURING CONSTANT G PULLOUT



NOTE

$$\Delta h = 0.08856 V_T^2 \ln \left(\frac{n - \cos \gamma}{n - 1} \right)$$

Δh = ALTITUDE LOST (ft)

V_T = TRUE AIRSPEED (kn)

n = NORMAL LOAD FACTOR

γ = FLIGHT PATH ANGLE

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Figure 3-2 Dive Recovery Chart (Sheet 1 of 2)

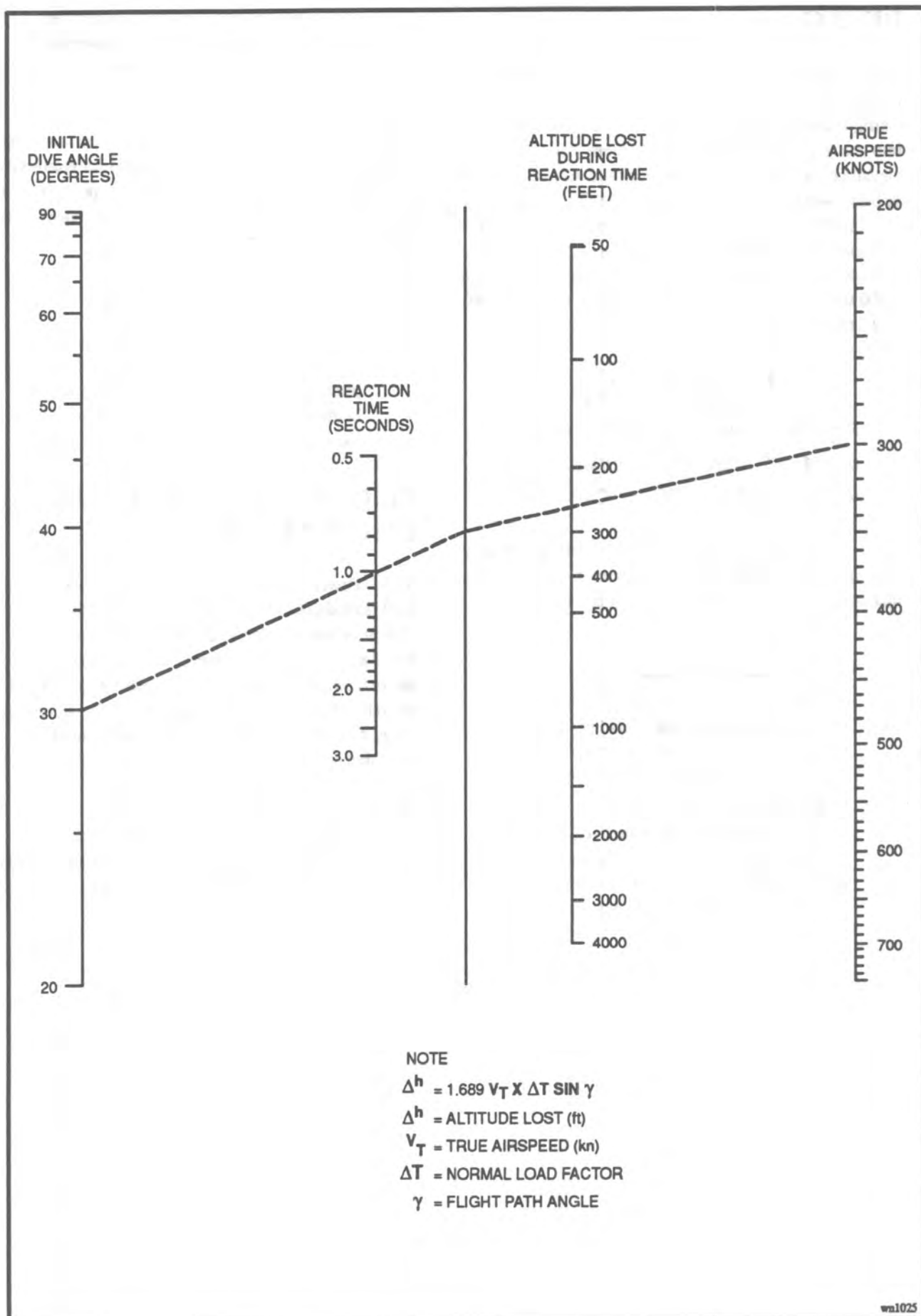


Figure 3-2 Dive Recovery Chart (Sheet 2 of 2)

DIVING

3.22 The diving characteristics of the aircraft are normal except when steep dives are conducted in a clean configuration from high altitudes where airspeeds increase into the supersonic range. Under these conditions, the elevator effectiveness will be reduced and the aircraft basic stability will become high, limiting the G available even with full aft stick. Dive recovery nomographs are provided in Figure 3-2. The altitude loss given is for a constant airspeed pull out. The actual altitude loss can be 1,000 ft to 2,000 ft greater than the computed values, due to aircraft acceleration at high power settings or steep dive angles.

WARNING

Figure 3-3 does not consider buffet onset or structural limits. See manoeuvrability chart, Figure 3-4.

3.23 The HUD G scale should be referred to immediately upon initiating a pullout from a supersonic dive to ensure that enough load factor is being developed to recover.

NOTE

If difficulty is experienced in recovering from a dive, speedbrakes should be opened immediately and throttle retarded in an effort to reduce airspeed and limit altitude loss in the recovery manoeuvre.

Maximum speed for fully effective opening of speedbrakes is 440 KIAS. Speedbrakes are partially effective up to maximum speed capabilities of the aircraft; however, a slow

uncommanded roll may occur at airspeeds above 400 KIAS due to asymmetric speedbrake extension. The roll is easily countered by small lateral inputs.

3.24 If the elevator power system should fail during a supersonic dive, the stick force required for recovery will be so high as to prohibit normal recovery procedures. Use of aircraft nose up stabilizer trim will then become mandatory to effect recovery.

NOTE

Do not use the horizontal stabilizer as a dive recovery device except in an emergency. A pitch up will occur as the airspeed drops below approximately Mach 0.94, increasing the chance of a structural overstress.

FLIGHT WITH POWER CONTROL DISCONNECTED

3.25 Power control disconnect above 300 KIAS or 0.80 IMN should be avoided. If possible, reduce thrust and deploy the speedbrakes to decrease the Mach number, and trim the aircraft laterally prior to the disconnect. At speeds above 0.90 IMN, with the power control disconnected, the aircraft suffers strong wing drop tendencies. In this speed range, high lateral stick forces reduce the available control such that it may be difficult to overcome the wing drop tendencies. Although the aileron tab retains some effectiveness, the slow speed of operation of this tab makes it difficult to keep up with the random wing drops. The wing drop tendency disappears as airspeed is reduced below 0.85 IMN, and lateral stick forces reduce, making the aircraft more controllable.

FLIGHT WITH EXTERNAL STORES

GENERAL

3.26 Flight characteristics with external stores fitted are satisfactory. Adequate control is available to hold the wings level during landing with an asymmetrical loading up to 7500 foot-pounds static moment. Wing heaviness or random wing drop may be encountered at medium altitudes (20,000 to 25,000 feet) and high subsonic speeds (between 0.94 and 1.0 IMN) when carrying certain stores, or in braked dives.

ASYMMETRIC LOADINGS

3.27 With asymmetric loadings, simple elevator control displacement induces roll as well as pitch. With control hydraulic power on, aileron control is sufficient to counteract roll induced by elevator control displacement.

With hydraulic power off, at speeds above 200 KIAS, the roll induced by elevator displacement cannot be adequately controlled because of high lateral stick forces. Accordingly, with hydraulic power off, longitudinal control should be minimized and air speed should not exceed 200 KIAS with asymmetrical loadings.

CG MOVEMENT

3.28 With various aft store loadings on the multiple ejection racks (MER), the CG will shift aft. In the event that the aft bombs fail to release due to a rack malfunction, the CG may exceed the permissible aft limit. As the CG moves aft, the longitudinal stick forces become very light and the aircraft control sensitivity increases. In this situation the landing may become extremely hazardous making it prudent to jettison the multiple bomb racks.

MANOEUVRING FLIGHT

ANGLE OF ATTACK RELATIONSHIP

3.29 The angle of attack relationship for the operational envelope of the aircraft is shown in Figure 3-3.

SPEEDBRAKES CLOSED

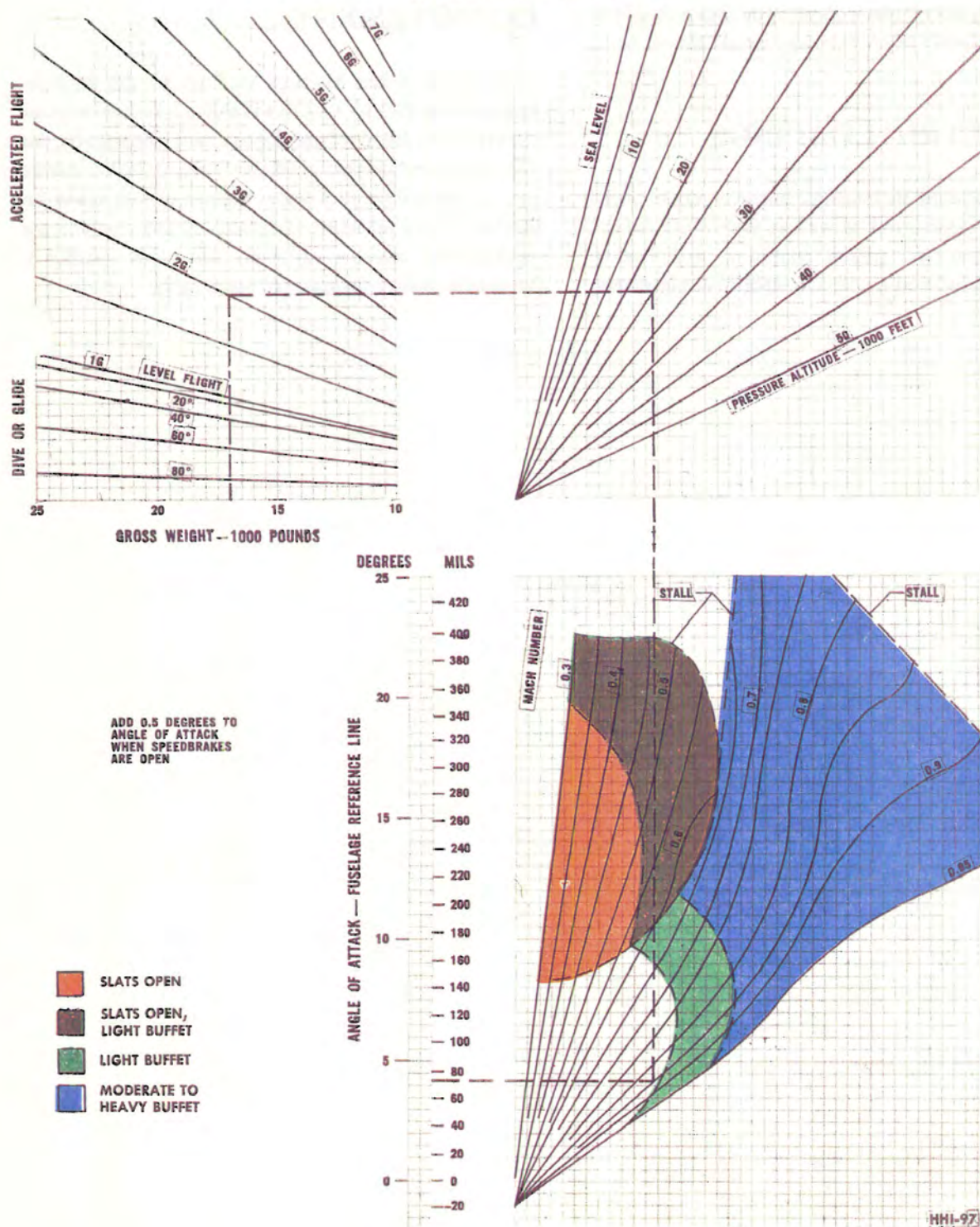


Figure 3-3 Angle-of-Attack Relationship (Sheet 1 of 2)

ANGLE-OF-ATTACK RELATIONSHIP SPEEDBRAKES CLOSED

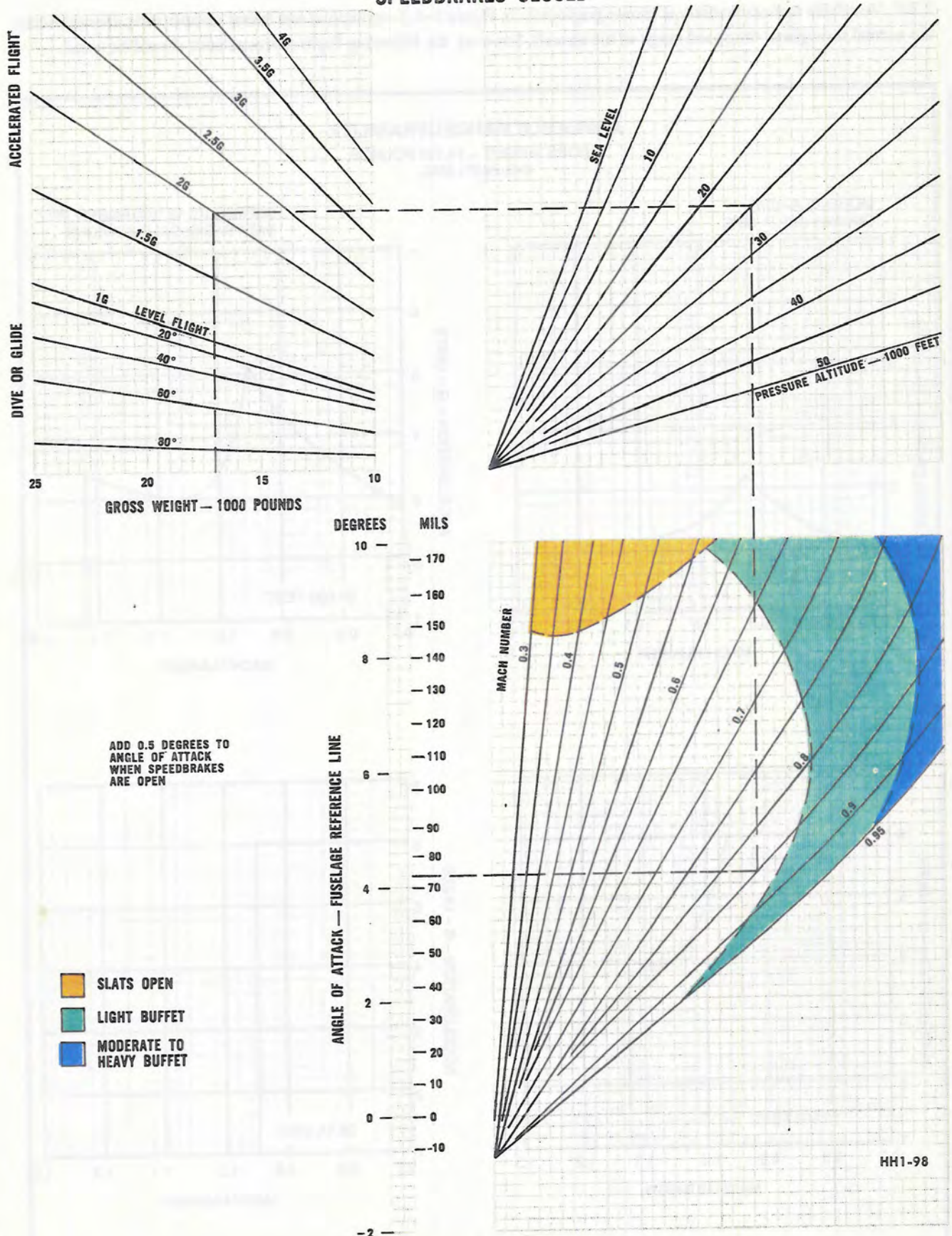


Figure 3-3 Angle-of-Attack Relationship (Sheet 2 of 2)

AL 7(0)

AVAILABLE MANOEUVRABILITY

3.30 Available manoeuvrability is shown graphically in Figure 3-4. Longitudinal and lateral manoeuvring characteristics are normal throughout the speed range of the aircraft, however, the following flight characteristics should be noted.

AVAILABLE MANOEUVRABILITY

GROSS WEIGHT = 14,721 POUNDS
C/G 20.9% MAC

MODELS: A-4E/F
ENGINE: J52-P-8B/C

DATA AS AT: 15 NOVEMBER 1972
DATA BASIS: CALCULATIONS

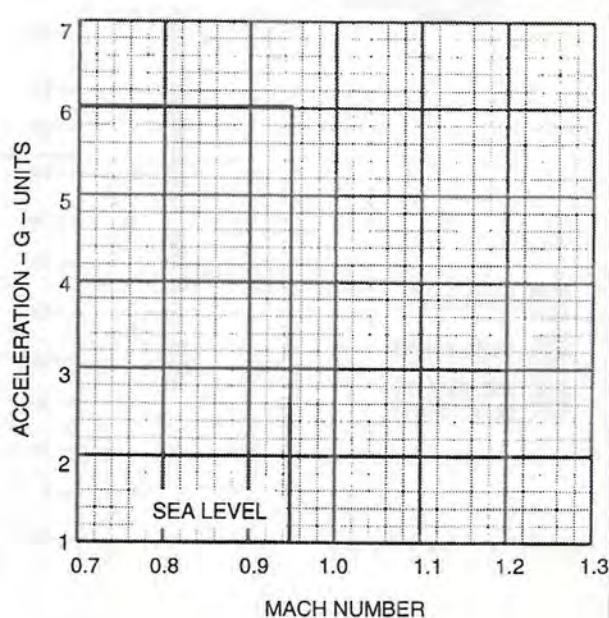
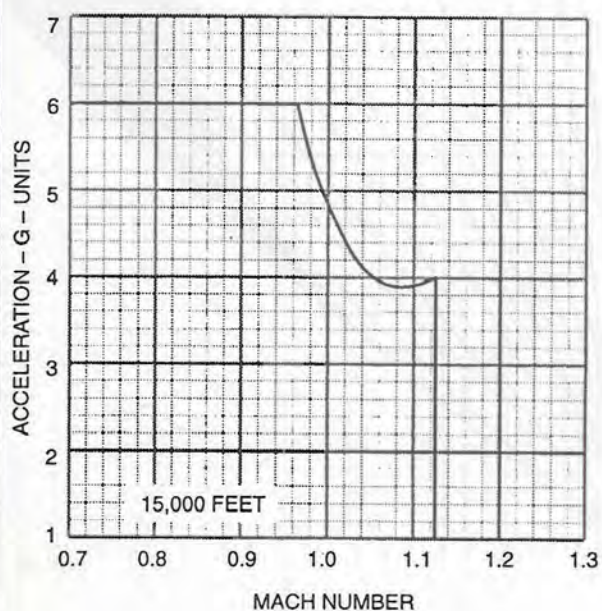
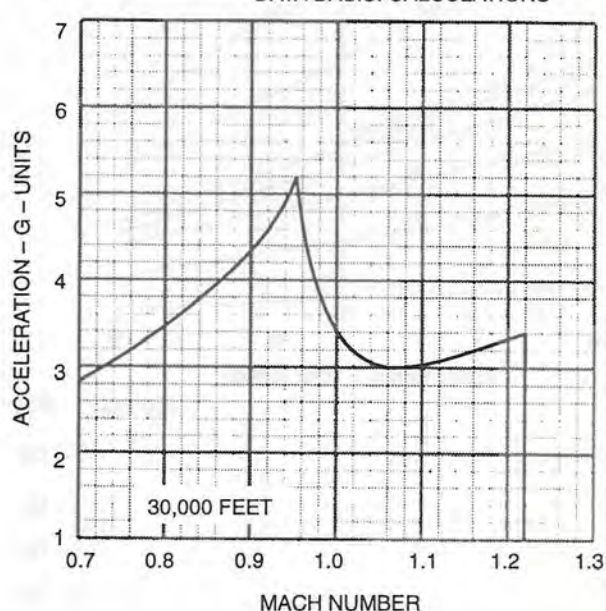
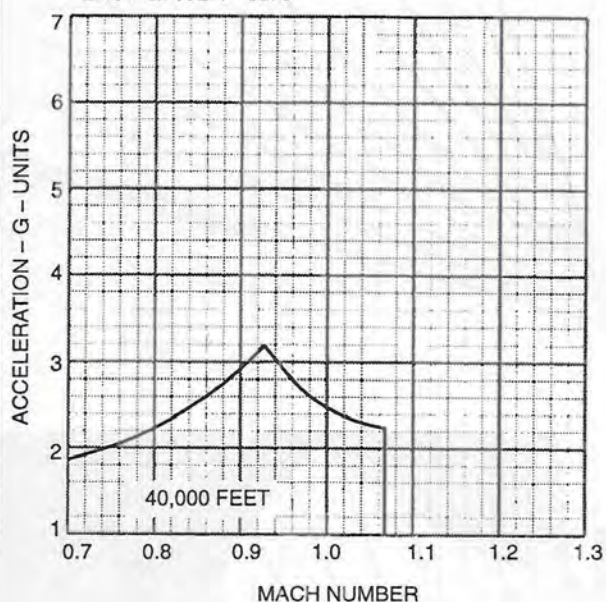


Figure 3-4 Available Manoeuvrability (Sheet 1 of 2)

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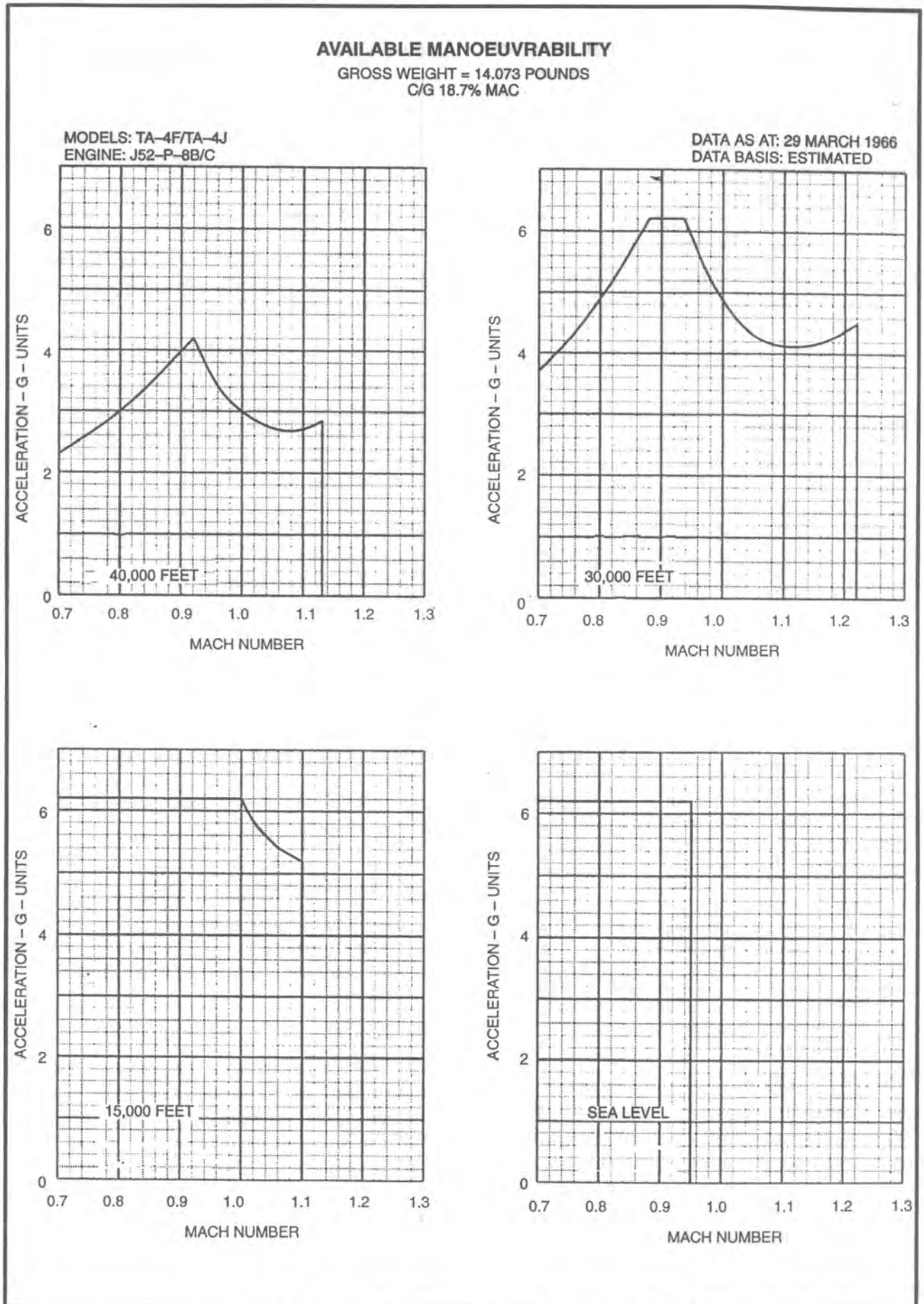


Figure 3-4 Available Manoeuvrability (Sheet 2 of 2)

ROLL CHARACTERISTICS

Aileron Rolls

3.31 During and upon termination of high rate aileron rolls (above 200 degrees per second) in the high speed, low altitude regime, abrupt pitch down will be noted. This pitch down, though uncomfortable, is structurally safe and aircraft structural limits will not be exceeded provided the roll is limited to 360 degrees.

CAUTION

When executing high rate, low altitude rolls (greater than 3/4 lateral stick input), apply recovery controls after completing 180 degrees of roll to prevent exceeding 360 degrees of roll.

Positive Rolling G

3.32 Positive G manoeuvring at high rates of roll induces high sideslip angles which results in an uncommanded pitch up. At high altitudes, this pitch up tendency increases the likelihood of an inadvertent stall. At low altitudes sideslip angles are reduced but the pitch up tendency is considerably stronger, increasing the risk of an airframe overstress.

Negative Rolling G

3.33 Negative G manoeuvring at high rates of roll, in the medium to high airspeed, low altitude regime, induces an uncommanded pitch down. This pitching tendency is a result of inertia cross coupling and is not noticeable in normal negative G rolling manoeuvres with a moderate roll rate. If bank angle changes are limited to 180 degrees or less, the pitch down will not be excessive, regardless of the lateral stick deflection used during the manoeuvre.

CAUTION

The pitch down, described above, can generate a negative load factor in excess of the structural design limit of the aircraft.

Directional Stability

3.34 Directional stability is dependent on the relationship of vertical stabilizer size and its displacement from the aircraft centre of gravity as compared to the area of the fuselage forward of the centre of gravity. Although the aircraft exhibits adequate directional stability throughout the normal flight envelope, high sideslip angles and yaw rates can easily develop during departures as the airspeed decreases below 100 KIAS, and the vertical stabilizer becomes less effective.

HIGH ANGLE-OF-ATTACK CHARACTERISTICS

Adverse Yaw

3.35 The Skyhawk is equipped with relatively large ailerons in order to provide sufficient roll control at landing and takeoff speeds. As a result deflection of the ailerons will generate adverse yaw, although it will not be particularly noticeable throughout the normal operating envelope. However, lateral inputs after a departure from a low airspeed, high angle-of-attack manoeuvre can generate excessive adverse yaw that may result in roll rates as high as 130 degrees per second and yaw rates as high as 40 degrees per second.

High Angle-Of-Attack Pitch Up

3.36 An uncommanded pitch up, with no change in stick position, may be encountered when applying G at high angle-of-attack with the centre of gravity located aft of approximately 24 percent MAC. This pitch up is normally preceded by buffet onset and an increase in buffet intensity. At altitudes above 30,000 feet, the aircraft G limit will not be exceeded if pitch up is encountered. At altitudes below 15,000 feet and speeds above 0.80 Mach, adherence to the G limit will preclude the aircraft from encountering pitch up. Between 0.50 and 0.80 Mach number with aft centre of gravity, it is possible to attain pitch up when manoeuvring near limit load factor. At intermediate altitudes of 15,000 to 30,000 feet, the pitch up can result in exceeding the G limit. The severity of the pitch up can be controlled by partial forward stick movement. The onset and increase in intensity of buffet serves as a warning that the pitch up boundary is being approached. Pitch up does not occur below Mach 0.40 and, therefore, does not present a landing or low speed handling problem.

CAUTION

Full forward stick should not be used to recover from a high angle-of-attack pitch up, as excessive negative load factors may occur.

Normal Stalls

3.37 Stall characteristics are normal in all configurations. The 1.0 G stall is characterized by a mild nose down pitch accompanied by small lateral and directional oscillations at approximately 24 units AOA. If the stall is reached at high power settings the magnitude of the nose down pitching is reduced. The approach to the stall is characterized by light airframe buffeting which steadily increases in intensity as AOA is increased. At the stall, the wing slats will be fully extended and the ailerons will remain effective. Full aft stick is required to stall the aircraft when pitch trim is less than 4 degrees nose up. Because of

limited elevator effectiveness, the aircraft will not stall inverted. The aircraft exhibits no tendency to depart controlled flight during the stall.

NOTE

Asymmetric slat extension may require full lateral control to maintain wings level when airspeed is 5 knots above the stall.

Accelerated Stalls

3.38 The accelerated stall is characterized by heavy airframe buffet and small longitudinal and lateral-directional oscillations. A light airframe buffet occurs just prior to slat extension after which the buffet disappears until AOA approaches the accelerated stall. Asymmetric slat extension, caused by load application during unbalanced flight, will cause an abrupt roll away from the extended slat. If the normal load factor is increased beyond this point, then this may result in an uncontrollable roll. This can easily be stopped by reducing the load factor.

Stall Recovery

3.39 The conventional technique of decreasing angle of attack by moderate forward stick displacement, and simultaneous application of full power should be used for the stall recovery. Although the ailerons are always effective, wing drop should be prevented with rudder until the aircraft is recovered. Optimum angle of attack is recommended for nose low recoveries. Recovery from accelerated stalls is easily accomplished by relaxing aft stick pressure.

NOSE-HIGH, LOW AIRSPEED CHARACTERISTICS

3.40 During manoeuvring flight, nose-high, low airspeed conditions may be encountered that necessitate termination of the manoeuvre and recovery to the normal flight regime. The aircraft should be manoeuvred under positive G to the nearest horizon while there is still sufficient airspeed available (approx 100 KIAS). If the airspeed is insufficient to recover the aircraft, actions for departure must be carried out.

3.41 Because of reduced directional stability, the TA-4 is more susceptible to inadvertent spin entry than the A-4. TA-4 flight tests have shown that lateral stick inputs of less than one inch have resulted in inverted spin entry from the 90-100 degree nose-high attitude with fuel remaining in the external drop tanks, or with stores loaded. Loss of stores and racks, and structural damage to the aircraft may result should an inverted spin occur.

WARNING

Intentional 90 to 100 degrees nose high, zero airspeed manoeuvres are prohibited in the TA-4 aircraft because of the possibility of inadvertent spin entry.

Intentional vertical nose-high zero airspeed manoeuvres should not be entered in the A-4 aircraft with fuel remaining in the external drop tanks or with stores loaded.

OUT OF CONTROL FLIGHT

INTRODUCTION

3.42 Out of control flight can be divided into three phases. These are: Departure, Incipient Spins and Steady State Spins.

Departure (Post-Stall Gyration)

3.43 When the aircraft leaves the region of normal flight and actuation of the flight controls does not result in the usual aircraft response.

Incipient Spins

3.44 That phase of the spin, after the post stall gyrations, when the aircraft is pitching, rolling, and yawing in a spin like motion, but prior to the time when a steady state spin has developed.

Steady State Spin

3.45 The phase of the spin when the aerodynamic and inertial forces are balanced and the aircraft pitching, rolling, and yawing motions are repeated in a cyclic fashion. The yaw rate is sustained, and the angle of attack is above the stall in either a positive or negative direction.

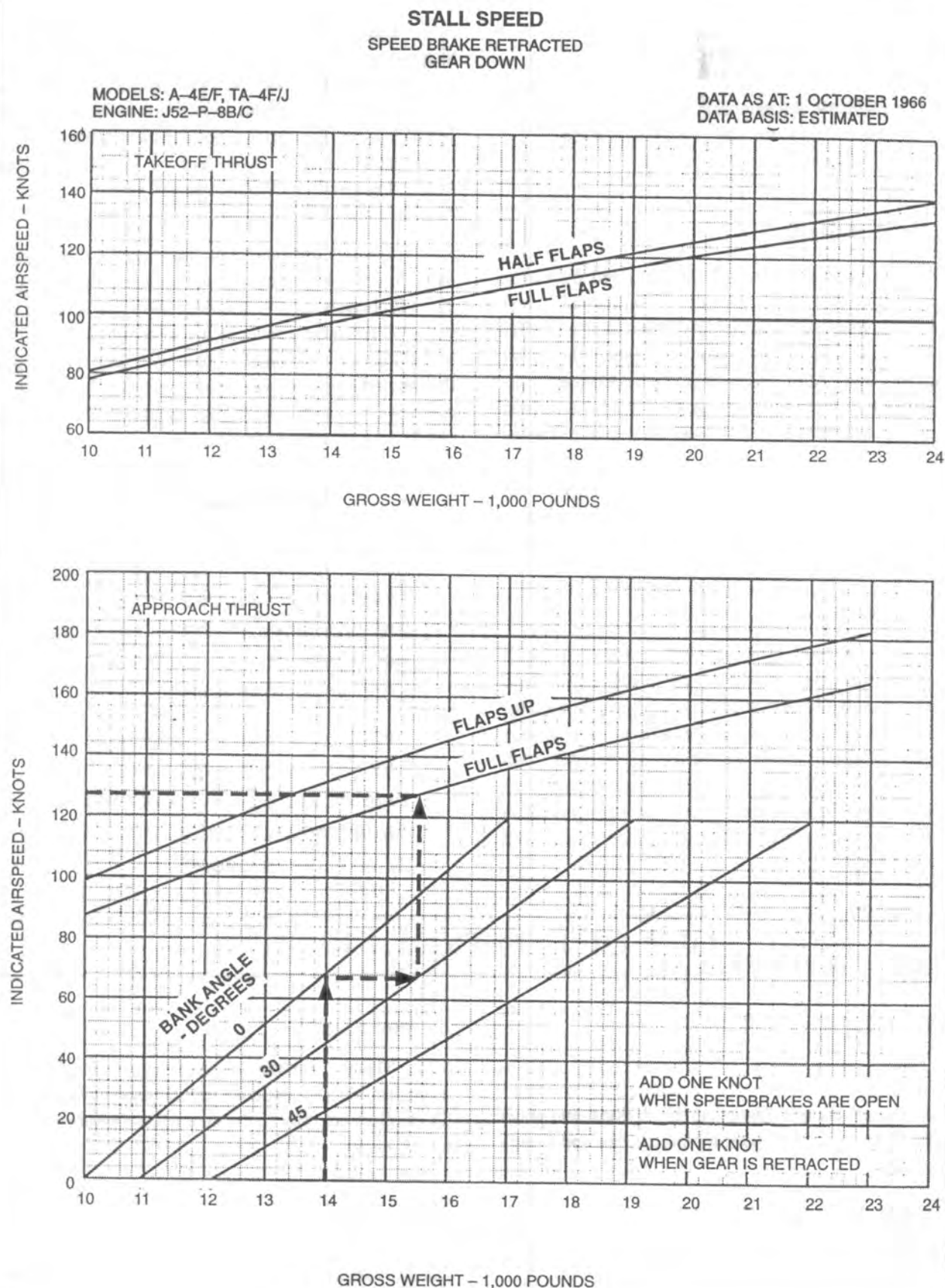


Figure 3-5 Stall Speeds

DEPARTURE

3.46 The Skyhawk aircraft is not departure prone; however, departures from controlled flight can occur as a result of nose-high, low airspeed conditions or asymmetric slat extension during accelerated stalls. Departures from nose high low airspeed conditions are characterized by an uncommanded nosedown pitch followed by random post-stall gyrations in roll and yaw. During the nose down pitch, the nose may swing through the vertical, in a pendulous fashion, before the aircraft stabilizes in a near vertical nose low dive with a rapidly increasing airspeed. Lateral or longitudinal control inputs must be avoided as they only aggravate aircraft motion and can result in large yaw excursions, prolonging the out of control flight condition and possibly leading to spin entry. Minor engine compressor stalls may occur and should serve as an added warning to neutralize controls and retard the throttle to below 80 percent. In some instances, departure characteristics include high roll rates at zero or negative load factor which can easily be confused with an inverted spin. In this case, the angle of attack will oscillate as airspeed continually increases.

CAUTION

Do not apply spin recovery controls unless a spin is confirmed by a sustained yaw rate with low airspeed and a pegged angle of attack.

NOTE

The aircraft is not spinning if the airspeed increases through 200 knots.

SPINS

General

3.47 In a fully developed spin, the rotation rate varies from 4 to 14 seconds per turn with an altitude loss of 2,000 to 7,000 feet per turn. Rate of descent will vary from 20,000 to 35,000 fpm. With proper recovery controls maintained, recovery from a fully developed spin may require up to three turns if erect and up to four turns if inverted. The ailerons are the most powerful recovery control and must be applied properly to recover from any spin.

Upright Spin Characteristics

3.48 The aircraft is very resistant to erect spin entry and generally requires pro-spin controls to be applied and maintained.

3.49 The most common erect spin is the steep oscillatory spin in which a 360 degree roll occurs during the first one or two turns. Roll and pitch oscillations occur continually after the first turn and vary ± 70 degrees in roll angle and 0 to 70 degrees nose down. There are frequent hesitations in spin rotation and the aircraft sometimes turns in a direction opposite to rudder deflection. No sustained yaw rate develops, airspeed usually increases as the spin continues, and angle of attack varies from 20 to 30 units.

3.50 Less frequently, relatively flat, erect spins have occurred, sometimes developing after several steep turns as described in the preceding paragraph. Aircraft roll oscillations vary between 20 degrees left and 20 degrees right wing down. Airspeed fluctuates between 50 and 150 knots, but does not increase as the spin progresses. The angle of attack will be pegged at 30 units. There is no hesitation in spin rotation, which is fast: 3 to 4 seconds per turn with an altitude loss of 1,200 to 1,500 feet per turn. Recovery from this spin mode will be slower than from the previously described erect steep oscillatory mode.

3.51 Erect spins entered from an accelerated stall have the same characteristics as those entered from 1.0 G flight, except that more violent snap-roll type manoeuvres occur during the first two or three turns.

Inverted Spin Characteristics

3.52 The inverted spin is oscillatory and extremely disorientating. Pitch attitude varies from the horizon to full 90 degrees down, and roll oscillations are erratic. The angle of attack indicator is near zero units, and the airspeed fluctuates between 50 and 150 knots. The aircraft sometimes executes 360 degree rolls while spinning inverted, and occasionally rolls to an erect position, pauses momentarily, and then continues inverted. During these rolls to the erect position, the angle of attack will oscillate through the full scale of the indicator, the turn needle will reverse as yaw rate changes direction, and G will become momentarily positive. Spins which exhibit this characteristic are referred to as the hesitant inverted mode. The spin rate is fast: 3 to 4 seconds per turn with altitude loss of 800 to 1200 feet per turn. Negative load factors of over -2.5 G have been experienced during inverted spins. High lateral accelerations caused by the high roll rates add to the overall disorientation of this flight condition.

SLAT OPERATING CHARACTERISTICS

NORMAL OPERATIONS

3.53 Under positive G flight conditions, the slats will initially extend in the 12 to 16 unit angle-of-attack range, and in 1.0 G flight, they will begin to extend below 200 KIAS. It is possible that even with properly adjusted slats initial opening may not occur until as slow as 170 KIAS. There is the possibility that each slat may open at a slightly different airspeed or angle of attack, however this does not present any control problems. During increasing normal acceleration the mild buffet cues present prior to slat extension will disappear upon initial slat opening, reappearing at some 2 to 3 units AOA later. Slat opening characteristics are affected by aircraft external configuration. The slats will open more abruptly and extend at a slightly higher AOA (i.e. approximately 0.5 to 1.0 unit higher) when the aircraft is clean.

WARNING

If acceptable slat performance is not achieved, all manoeuvring flight should be terminated and the AOA maintained below 19 units.

ASYMMETRIC SLAT CHARACTERISTICS

3.54 During manoeuvring flight, slat extension asymmetry frequently occurs as a result of slat track binding due to the aeroelastic bending and twisting effects of the wing and/or uncoordinated flight. Sideslip angles greater than 1 degree (i.e., one ball width out of trim) cause 1 unit AOA difference in slat deployment up to 300 KIAS, and 2 units AOA at higher airspeeds. The Skyhawk exhibits three asymmetrical slat conditions; these are: Poor Slat Modulation, Slat Locked Out, and Slat Locked In.

Poor Slat Modulation

3.55 This is extremely common during manoeuvring flight and is characterized by the slats failing to move

smoothly and in unison over the full range of travel. The aircraft may still be flown aggressively in unaccelerated or accelerated flight up to 24 units AOA without loss of control, however, there will be wing drop associated with abrupt slat movement.

Slat Locked Out

3.56 The aircraft is fully controllable up to 425 KIAS in this condition. In unaccelerated flight, the aircraft will exhibit a roll away from the extended slat which can be controlled with small amounts of opposite aileron. The amount of aileron required decreases as load factor is increased. So long as the second slat operates on schedule, no other abnormal handling qualities exist.

Slat Locked In

3.57 This is the most serious asymmetric slat condition and can result in out-of-control flight. The aircraft is fully controllable in both unaccelerated and accelerated flight up to 19 units AOA. When 19 units AOA is exceeded there is the possibility of a very abrupt lateral-directional loss of control with uncommanded roll rates, in excess of 140 degrees per second. If rapid full aileron inputs are used to counter this roll severe adverse yaw rates in excess of 30 degrees per second will be generated within the first 90 degrees of roll. Recovery is quickly accomplished if controls are immediately neutralized.

AERODYNAMIC LOCKOUT

3.58 Because of the large angle between the plane of the slat chordline and the wing chordline, the slat can develop large negative angles of attack if fully extended at airspeeds above 200 KIAS. This can occur during pushovers or extended inverted flight and will result in the slats remaining fully extended due to high aerodynamic forces. This aerodynamic lockout of the slats can be overcome by slowing the aircraft, thereby reducing the negative AOA and drag force. Slats should retract at approximately 200 KIAS. No degradation in flying qualities will result from this phenomenon, and the aircraft is fully controllable even if one slat is fully extended and the other is retracted so long as the AOA is maintained below 19 units.

FLIGHT CHARACTERISTICS ON AFCS

INTRODUCTION

3.59 When flying hands off, the aircraft is completely stable about all three axes, with no tendency to oscillate. Certain flight characteristics of the AFCS are inherent in its design and constitute normal performance. Flight characteristics which are evident to the pilot are discussed in the following paragraphs.

WING DOWN PHENOMENA ON HEADING HOLD

3.60 There are particular circumstances which may result in temporary wing down condition while on heading hold. Asymmetric loading and speed changes result in changes in the aircraft's directional trim and if not corrected with rudder trim will result in the aircraft maintaining a constant skid at a banked attitude.

ROLLBACK ON ROLL ATTITUDE HOLD

3.61 Control stick steering switching levels and pilot technique, in conjunction with the ability of the AFCS to synchronize changes in roll attitude, will determine the amount of rollback obtained on roll attitude hold. The roll synchronizer will lock onto the bank angle at the time the force on the stick passes below 2 pounds. If the control stick is released before the roll rate has decreased to zero the aircraft will overshoot and the rollback can be as much as 5 degrees to the AFCS bank reference. To prevent rollback, the desired bank angle has to be held in control stick steering mode for approximately 2 seconds.

CONTROL STICK STEERING FEEL

3.62 The flight characteristics when in control stick steering mode are the same as for the basic aircraft, except that the control stick experiences a change in feel which is the result of roll rate feedback and mode switching. Slight stick transients caused by the automatic return to the heading hold mode occur when making small bank angle or heading changes. These transients will be observed whenever the stick force varies above or below the 2 pound

level and the aircraft is at a bank angle of less than 5 degrees. Such transients are normal and result from the design characteristics of the heading hold mode.

Pitch

3.63 In control stick steering mode, forces are provided by electrical signals from the INU and elevator deflection. The resulting electrical feel is slightly lower than that of the normal power control. There is less variation in stick force per G over the flight regime. The breakout force in control stick steering mode has been reduced to 2 pounds, as compared with 3 pounds on normal power control.

Roll

3.64 Aileron control forces in the control stick steering mode are slightly lower than normal power control forces. Breakout forces are 2 pounds and 3 pounds respectively.

Yaw

3.65 The rudder control forces and breakout forces are identical in both modes.

CONTROL STICK STEERING ENGAGE TRANSIENTS DURING AUTO TRIM

3.66 The AFCS is equipped with automatic pitch trim which operates within 4 to 6 seconds after establishing a new flight condition. If the pilot should elect to go back into control stick steering before the automatic trim system has stabilized, he may encounter a control stick engage transient. This is normal and will not occur if the pilot remains out of the CSS mode longer than 6 seconds.

SENSITIVE REGIONS OF PRESELECT HEADING

3.67 Abrupt roll transients will occur on preselect heading if the SET knob is adjusted to command a turn in a direction opposite to the turn being made. The same phenomenon will occur if a heading change greater than 180 degrees to the present aircraft heading is commanded while the aircraft is stabilized in the preselect heading turn, since the preselect heading mode is designed to take the shortest path to the selected heading.

LONGITUDINAL STICK MOTION DURING AUTOMATIC TRIM

3.68 Automatic trim is provided when the AFCS is engaged. When the automatic trimming occurs, the stick will move longitudinally. This movement arises from two sources, the geared elevator effect and the relief of trim. The elevator is mechanically geared to the stabilizer so that any motion of the stabilizer will result in a motion of the elevator. Trim relief occurs when the elevator is returned to

the zero position as the stabilizer moves to maintain aircraft trim. In event of a manoeuvre such as a prolonged high G turn in attitude hold, automatic trim of the horizontal stabilizer will result in 2 to 3 degrees nose up stabilizer. As the speed decreases additional nose up trim is required. The automatic pitch trim operates within 4 to 6 seconds after establishing a new flight condition. Should the AFCS be disengaged at this time, and the aircraft returned to level flight, up to 15 pounds stick force may be required to hold the aircraft level.

AL 8(0)

CHAPTER 4

OPERATING LIMITATIONS

	PAGE		PAGE
ENGINE LIMITATIONS	4-1	GROSS WEIGHT LIMITATIONS	4-3
RPM	4-1	ASYMMETRIC LOAD LIMITATIONS	4-3
EGT	4-1	AUTOMATIC FLIGHT CONTROL SYSTEM ..	4-5
OIL QUANTITY/PRESSURE	4-2	AFCS Performance And Power Limitations ..	4-5
Ground	4-2	ACCELERATION LIMITATIONS	4-6
Inflight	4-2	PRESSURIZED WING TANK LIMITATIONS ..	4-6
AIRFRAME LIMITATIONS	4-2	TYRE SPEED LIMITATIONS	4-6
PROHIBITED MANOEUVRES	4-2	AIR REFUELLING STORE	4-9
AIRSPEED LIMITATIONS	4-2	STORE LIMITS	4-9
CENTRE OF GRAVITY LIMITATIONS	4-3	WING FUEL TANK PRESSURIZED	4-9

FIGURES

FIGURE		PAGE	FIGURE	PAGE
4-1	Airspeed Limitations	4-2	4-3	AFCS Speed Envelope
4-2	Asymmetric Wing Station Load Limitation Nomogram	4-4	4-4	Acceleration Limits vs Gross Weight
			4-5	Operating Flight Strength Diagram

TABLES

TABLE		PAGE	TABLE	PAGE
4-1	Fuel Specifications	4-1	4-3	EGT
4-2	RPM Variations	4-1	4-4	AFCS Flight Restrictions

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AL 5(0)

CHAPTER 4

OPERATING LIMITATIONS

ENGINE LIMITATIONS

4.1 Restrictions to be observed in the operation of the engine are based upon the use of the following fuel specifications:

Table 4-1 Fuel Specifications

	<u>Fuel Grade</u>	<u>NATO No</u>	<u>Specific Gravity</u>
Recommended	JP-8	F-34	0.805
Alternatives	JP-4	F-40	0.769
	JP-5	F-44	0.817
	JET A-1	F-35	0.805

4.2 Engine limitations are based on combinations of engine speed and exhaust gas temperature (EGT).

RPM

4.3 Rpm varies between engines at MILITARY thrust. For each engine, the specific rpm required to produce MILITARY static thrust under standard day conditions is placarded on the engine data plate. Most engines will fall in the range of 95 to 100 percent. The pilot should therefore expect to see MILITARY rpm indicated in this range at full throttle. The rpm at MILITARY thrust also varies noticeably with changes in inlet temperature. The amount of variation from data plate rpm depends on the type of fuel control unit installed but is approximately +1 to -2 percent for extreme conditions of hot and cold respectively.

Table 4-2 RPM Variations

<u>Condition</u>	<u>RPM %</u>
Max Overspeed	102.9 (12,400 rpm).
Max Operational	101
Max continuous	Military - 3
Minimum inflight	70
Minimum Take off	95

CAUTION

A minimum inflight rpm of 70% should be maintained to preclude a possible flameout.

EGT

Table 4-3 EGT

<u>Condition</u>	<u>EGT °</u>	<u>Time</u>
Acceleration	680	8 minutes
Military	650	30 minutes
Max Continuous	595	unlimited
Idle	340	(guide only)
Start to idle	455	2 minutes

NOTE

If, during start, EGT exceeds 455 deg five times, or reaches 531 deg for one period of 5 seconds or more, engine must be subjected to an over temperature inspection. Any EGT exceeding 565 deg for any period of time will require a teardown inspection of all hot section parts.

After 8 minutes, at MILITARY thrust, the EGT should have reduced to below 650 deg. If this does not occur the pilot should control EGT using the throttle, however the engine should be made unserviceable at the completion of the sortie.

The military operating time of 30 minutes is not intended as a limit, but as a guide to prolong engine life. Engine life deteriorates more rapidly by cycling the engine from military power to a lower power setting for short periods than by operating the engine at military power for 30 minutes or more. The 30-minute time limit at MILITARY thrust is a power level limit as well as a temperature limit; that is a particular engine which develops MILITARY thrust at an exhaust gas temperature of 540 deg is still limited to 30 minutes at this power even though it is below the MILITARY operating temperature limit.

AL 12(8)

OIL QUANTITY/PRESSURE

Ground

4.4 During the 'press-to-test' check during pre-start checks, the oil quantity light should illuminate within $\frac{1}{2}$ - 3 seconds of pressing the test button. The oil pressure indication at IDLE RPM should be between 40 to 50. A minimum oil pressure of 30 psi is acceptable for ground operation provided oil pressure rises above 40 psi at 60 percent RPM. If the oil pressure fails to rise above 40 psi the engine should be shut down and the cause of low oil pressure determined.

Inflight

4.5 The 80% oil quantity light must be carried out by the top of the climb or 8 minutes whichever is the latter. During steady state flight, normal oil pressure limits are 40-50 psi. Oil pressure above 50 psi can cause failure of internal engine oil seals and result in loss of oil to the engine. Manoeuvres producing accelerations near zero g may cause reduced or complete loss of oil pressure, the time limits in these situations are as follows:

1. Ten seconds for zero oil pressure,
2. One minute for less than 40 psi.

AIRFRAME LIMITATIONS

PROHIBITED MANOEUVRES

4.6 The following Manoeuvres are prohibited:

1. Negative g flight in excess of 10 seconds.
2. Intentional spins.
3. Aileron rolls that:
 - a. Exceed 360 degrees of roll.
 - b. Exceed one-half stick deflection with fuel in external fuel tanks. Above 20,000 feet, full stick deflection may be used for rolls up to 180 degrees.
4. Hesitation rolls.
5. Maximum permissible change in angle of bank during rolling pullouts or rolling pushovers is 180 degrees.
6. Intentional decelerations to zero airspeed at pitch attitudes of 90 to 100 degrees nose-high.
7. Sustained normal accelerations between plus 0.5 g and minus 0.5 g due to possible engine fuel starvation from a loss of boost pump fuel transfer.
8. Manoeuvres with drop tanks pressurized that may result in a departure from controlled flight, or manoeuvring flight resulting in high roll rates

and negative g. Additionally, for dual drop tank aircraft, drop tank fuel transfer shall not be selected during any manoeuvring flight when the tanks are empty due to the possibility of uncommanded fuel dump.

AIRSPEED LIMITATIONS

4.7 The maximum permissible indicated airspeeds in smooth or moderately turbulent air are as follows:

1. With no external stores and with landing gear, flaps, and hook retracted, as shown in Figure 4-1.

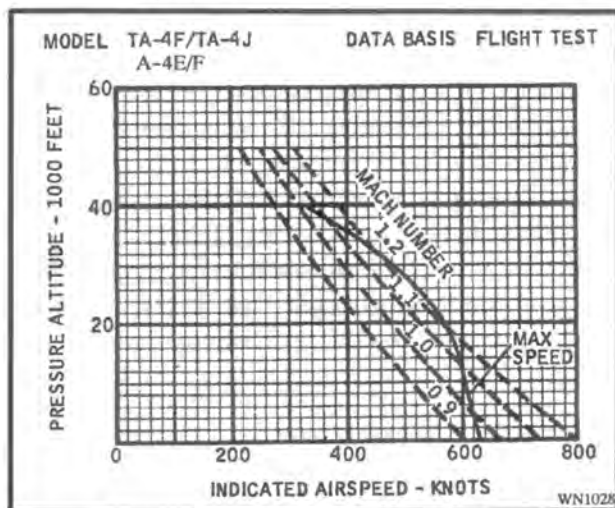


Figure 4-1 Airspeed Limitations

AL 9(0)

2. Landing Gear and Flaps extended (except in emergency to lock gear down):
 - 225 KIAS (zero yaw)
 - 170 KIAS (unrestricted yaw)

CAUTION

With flaps extended, 240 KIAS should not be exceeded without an indication of flap blowback, to prevent structural damage should the blowback relief valve fail to operate properly.

3. Flight Controls Disconnected:
 - 300 KIAS/0.8 IMN (symmetric loading)
 - 200 KIAS (asymmetric loading)
4. Emergency Generator Extended:
 - 500 KIAS / 0.91 IMN
5. Canopy open on Ground (TA-4): 60 kts
6. Store Limitations:
 - a. Drop Tanks (All sizes):
 - 575 KIAS/0.9 IMN

NOTE

With external drop tanks fitted, fuel system venting via the vent mast may occur at 0.85 IMN.

- b. Buddy Store Carriage:
 - 500 KIAS/0.8 IMN;
 - refuelling 300 KIAS/0.8 IMN;
 - hose retraction 250 kts.
- c. LOX Pod: 400 kts / 0.8 IMN +4G
- d. Luggage Pod: 550 kts / 0.9 IMN +4G

NOTE

The underwing LOX container and the Luggage Pod should be regarded as ferry items only. Maximum load for the Luggage Pod is 100lbs.

For other external store limitations/loading, refer to the Tactical Manual, NZAP 6213.005-1.1.

CENTRE OF GRAVITY LIMITATIONS

- 4.8 Refer to Weight and Balance Handbook NAVAIR 01 1B-40 for operating limitations.

GROSS WEIGHT LIMITATIONS

- 4.9 The maximum recommended gross weights are as follows:

1. Field takeoff:
 - 24,500 pounds
2. Field landing minimum rate of descent:
 - 16,000 pounds
3. Field landing (normal and field arrestments):
 - 14,500 pounds

CAUTION

All external fuel tanks must be empty prior to arrested landings.

NOTE

Arrested landings can be made with stores such as empty rocket pods, or other light weight stores. Field landings at gross weights in excess of 16,000 pounds should be attempted only in an emergency. Barrier engagements are not recommended.

ASYMMETRIC LOAD LIMITATIONS

- 4.10 Asymmetrical store loading up to 7500 foot pounds of static moment on either wing are permitted for takeoff. Asymmetric load at outboard station times 9.48 plus asymmetric load at inboard station times 6.25 must not exceed 7500 foot-pounds (Refer Figure 4-2).

- 4.11 Landings are permitted with an asymmetric store loading up to 12,500 foot-pounds. The minimum approach speed is 115 knots with up to 7500 foot-pounds asymmetric moment, varying linearly to 130 knots at 12,500 foot-pounds. For rapid computation of allowable asymmetric loading refer to Figure 4-2

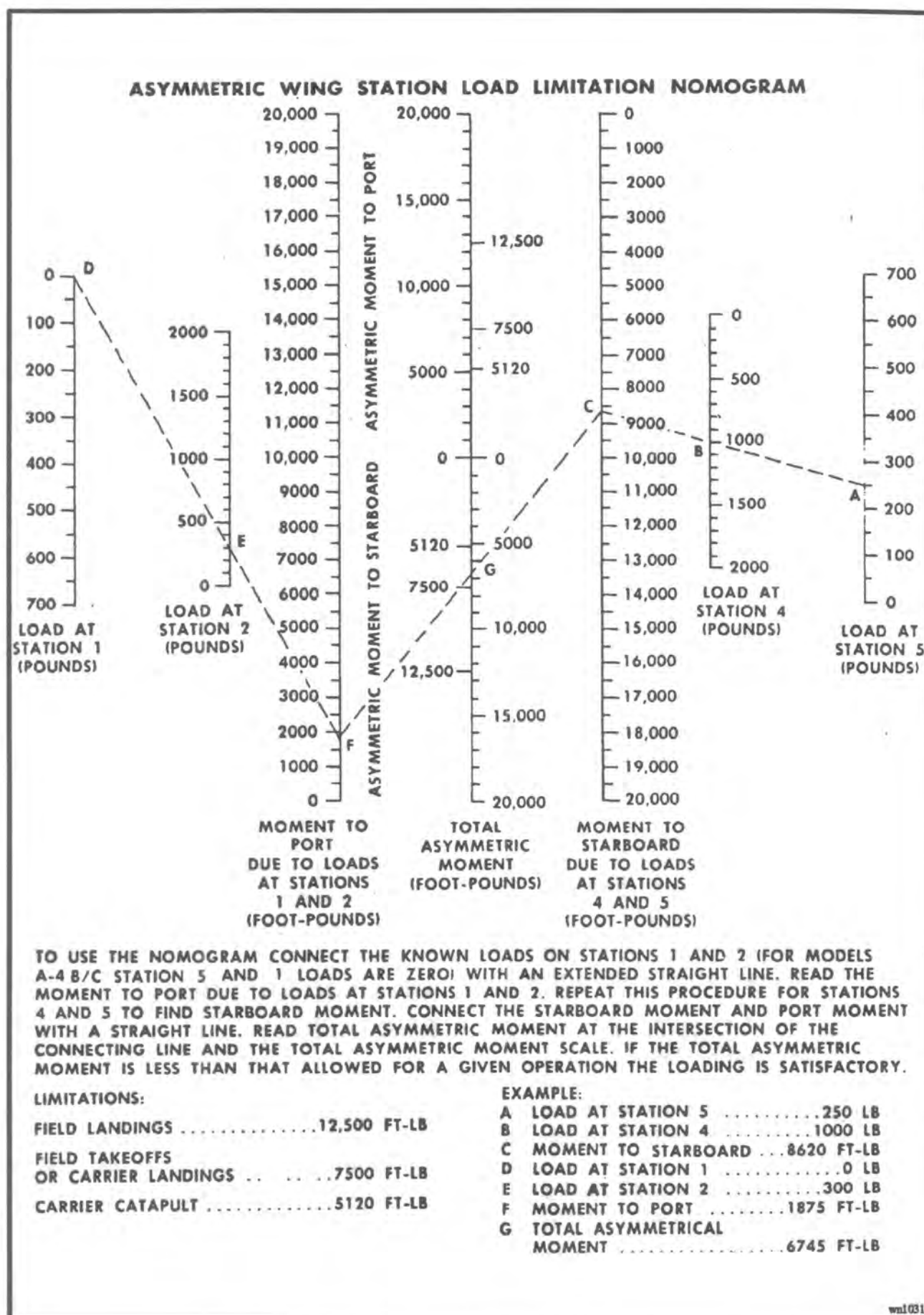


Figure 4-2 Asymmetric Wing Station Load Limitation Nomogram

AL 8(0)

AUTOMATIC FLIGHT CONTROL SYSTEM

4.12 At altitudes of 7500 feet AGL and above, operation of the AFCS is unrestricted throughout the speed range of the aircraft (Figure 4-3). The AFCS may be engaged below 7500 feet with restrictions as shown in Table 4-4.

NOTE

Yaw stability augmentation operation is unrestricted throughout the aircraft flight envelope.

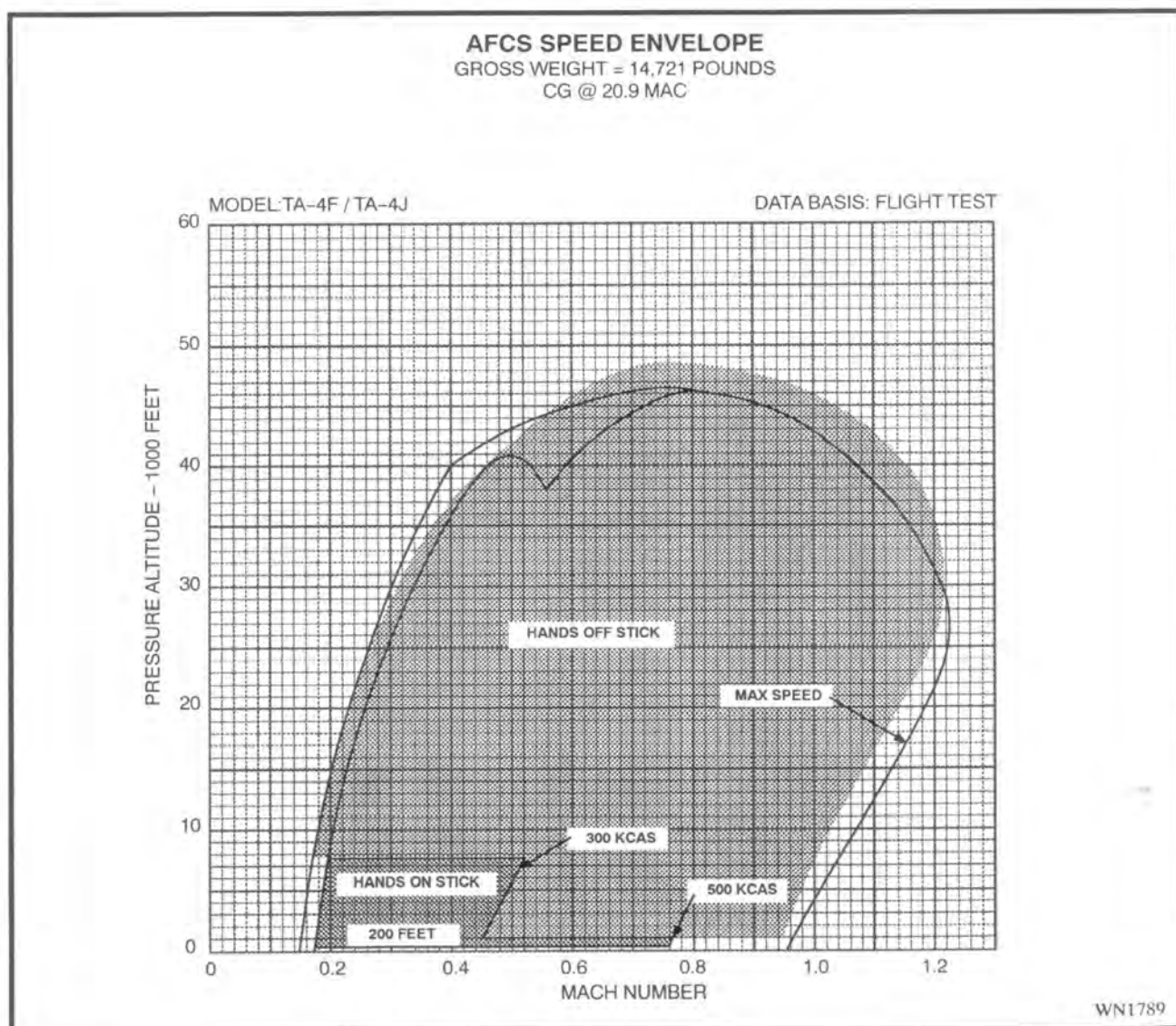
AFCS Performance And Power Limitations

4.13 The attitude hold, preselect heading, altitude hold modes all operate within the 60-degree pitch and

70-degree roll angle limits of the AFCS. It must be realized that within these limits each mode is further limited by the attitude, gross weight, and power performance of the basic airframe.

Table 4-4 AFCS Flight Restrictions

Flight Condition	Restriction
400 – 7500 ft AGL/ASL	Operation below 300 KIAS requires hands on control column monitoring.
200 – 400 ft AGL/ASL	Hands on control column monitoring 200 – 500 KCAS. Elsewhere operation prohibited.
Below 200 ft AGL/ASL	Operation prohibited.



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Figure 4-3 AFCS Speed Envelope

ACCELERATION LIMITATIONS

4.14 Accelerations at which moderate buffeting occurs shall not be exceeded. Otherwise, the maximum permissible accelerations for flight are as shown in Figure 4-4. In moderate turbulence reduce deliberate accelerations to minimize the possibility of over stressing the aircraft as a combined effect of gust and manoeuvring loads. Transonic pitchup can occur during speed reductions in the transonic region. Buffet onset and flight strength limits at low altitude combat conditions are shown in Chapter 9.

CAUTION

To minimize the probability of exceeding the maximum permissible load factor because of the combined effects of manoeuvring load factor and transonic pitchup, the following procedure is recommended:

1. Below 15,000 feet, at speeds in excess of 0.94 IMN, avoid deliberate accelerations in excess of +4g.
2. Above 15,000 feet, avoid deliberate accelerations that exceed buffet onset.

PRESSURIZED WING TANK LIMITATIONS

4.15 The following is a summary of the restrictions applicable to flight with the wing tank pressurized (i.e. **EMER TRANS** selected on the engine control panel or **TO STORE** selected on the Air Refuel Store control panel):

1. Aircraft velocity not to exceed 400 KIAS.
2. No landings.
3. Coordinated turns only.
4. Aircraft load factor limits +0.1 to +2.0G
5. No air refuelling.
6. No steep nosedown attitudes.
7. 45-degree bank maximum.

TYRE SPEED LIMITATIONS

4.16 A maximum of 175 knots ground speed is imposed upon the aircraft during ground operations due to structural limits of the tires. The limit is depicted in the takeoff charts by broken lines for various pressure altitudes.

AL 7(0)

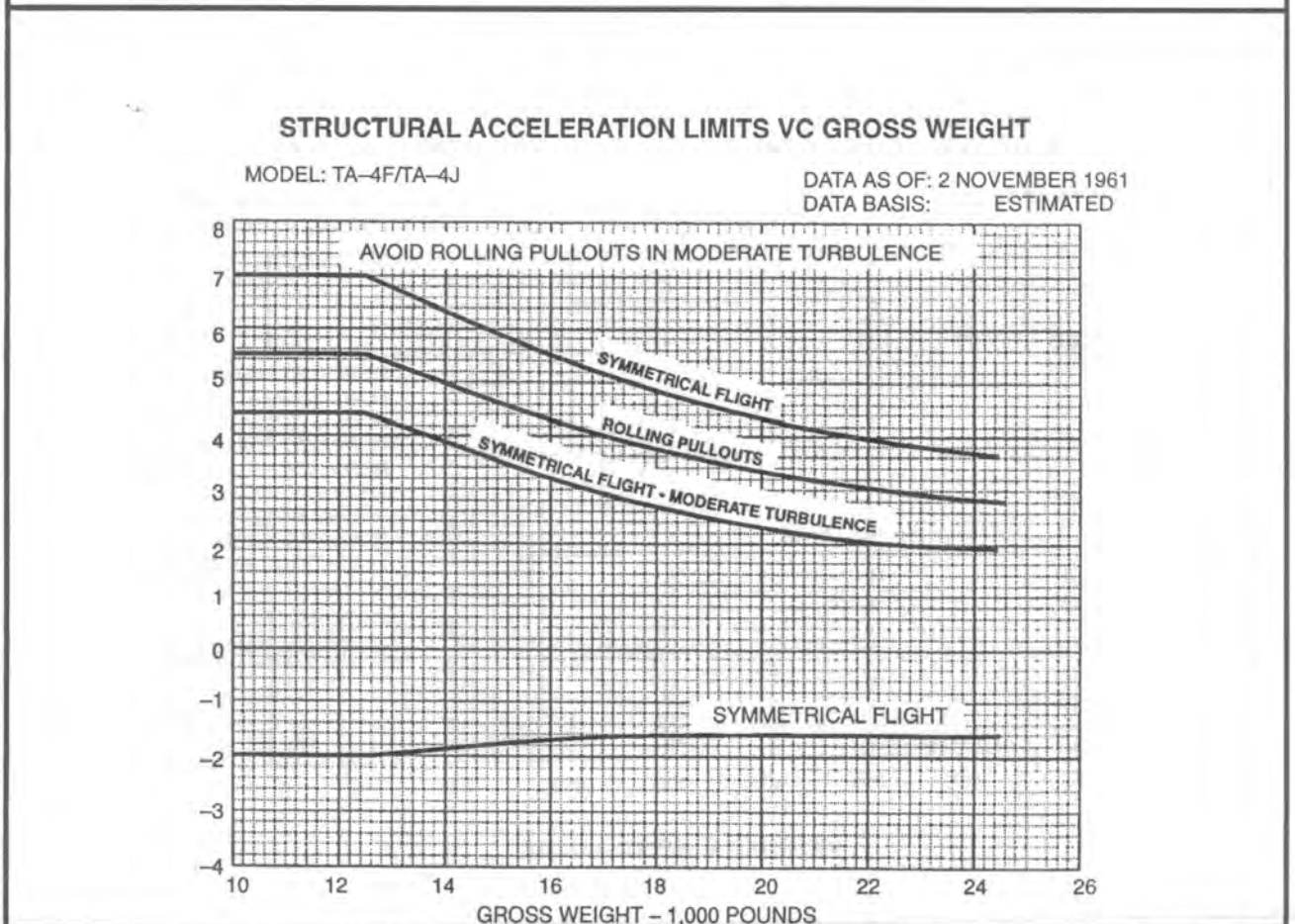
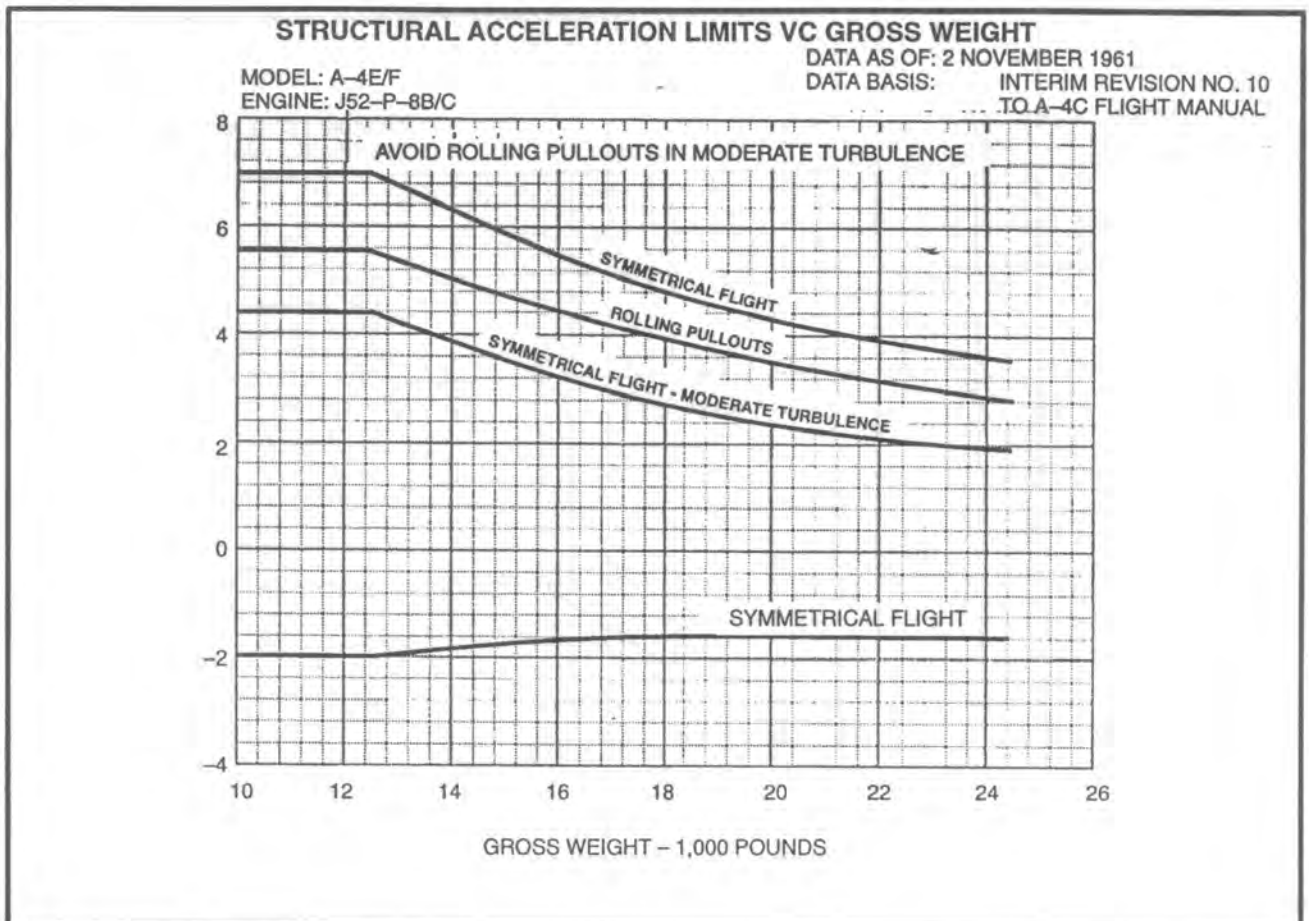


Figure 4-4 Acceleration Limits vs Gross Weight

AL 7(0)

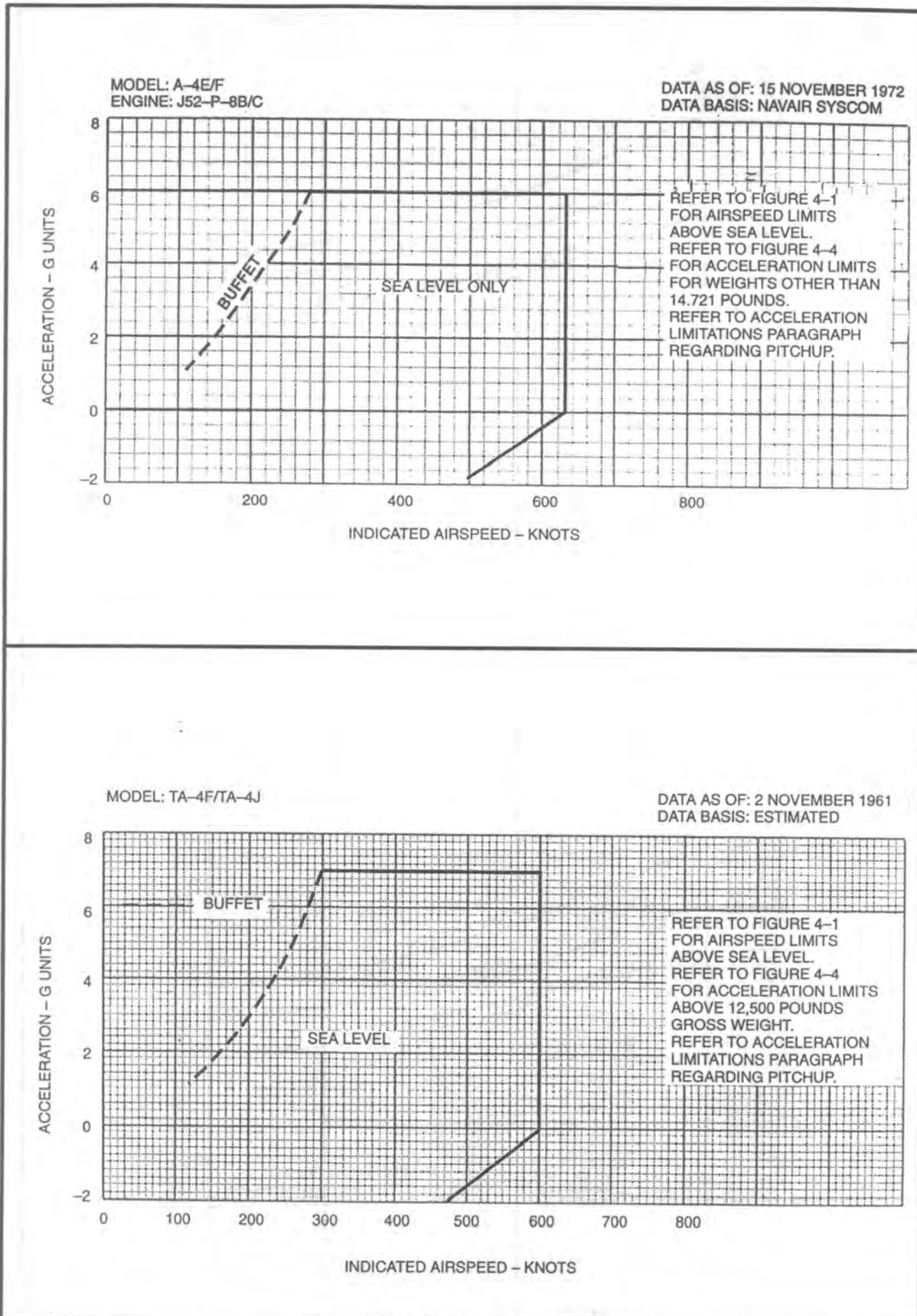


Figure 4-5 Operating Flight Strength Diagram

AIR REFUELLING STORE

STORE LIMITS

4.17 The following limitations apply to the store:

1. Maximum speed for unfeathering is 300 KIAS; for extension of the drogue and refuelling, it is 300 KIAS or 0.80 IMN. The recommended unfeathering and extension speed for training is 250 KIAS or less.
2. Maximum speed for drogue retraction is 250 KIAS. (If the drogue will not retract fully at

250 KIAS, slow to 230 KIAS or less and recycle drogue).

3. Conduct refuelling operations in straight and level flight whenever possible and, if possible, do not select **TO STORE** until 50 gallons of fuel has been delivered to the receiver.

WING FUEL TANK PRESSURIZED

4.18 The wing tank pressurized limits in paragraph 4.15 apply whenever the Air Refuelling Store is carried and **TO STORE** is selected.

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AL 8(7)

CHAPTER 5

EMERGENCY PROCEDURES

PAGE	PAGE
GENERAL	5-1
GROUND EMERGENCIES	5-1
ABNORMAL STARTS	5-1
Hung, Hot or Wet Start	5-1
Hung Start	5-1
Hot Start	5-1
Wet Start	5-1
False Start	5-2
ENGINE FIRE DURING START/SHUTDOWN	5-2
WING OR ACCESSORY SECTION FIRE	5-2
BRAKE FAILURE DURING TAXI	5-2
HOT BRAKES	5-2
TAKEOFF EMERGENCIES	5-3
ENGINE FAILURE DURING TAKEOFF ROLL	5-3
NOSEWHEEL STEERING MALFUNCTION	5-3
RUNAWAY NOSEUP TRIM/NOSE	
PITCH UP ON TAKEOFF	5-3
RUNAWAY NOSEDOWN TRIM	5-3
Inadvertent Flight Control Disconnect	5-4
ABORTING TAKEOFF	5-4
BLOWN TYRE ON TAKEOFF	5-5
RETRACTION RELEASE SWITCH:	
AIRBORNE – MALFUNCTIONS	
TO GROUND	5-5
UNSAFE GEAR-UP INDICATION	5-5
HANDLING EMERGENCIES	5-6
DEPARTURE FROM	
CONTROLLED FLIGHT	5-6
SPIN RECOVERY	5-6
Upright Spin Recovery	5-6
Inverted Spin Recovery	5-7
ASYMMETRIC SLAT DEPLOYMENT	5-7
Slat Lockout	5-7
MIDAIR/BIRDSTRIKE/COMBAT	
STRUCTURAL FAILURE OR DAMAGE	5-8
ENGINE MALFUNCTIONS	5-9
CHUGS AND STALLS	5-9
RPM/EGT MALFUNCTIONS	5-9
ENGINE OVERTEMPING	5-9
THROTTLE LINKAGE FAILURE	5-10
STUCK THROTTLE	5-10
FUEL CONTROL MALFUNCTIONS	5-10
ENGINE DRIVEN FUEL PUMP	5-10
OIL SYSTEM MALFUNCTIONS	5-11
HIGH OIL PRESSURE	
(OVER 50 PSI)	5-11
LOW OIL QUANTITY/PRESSURE	5-11
TOTAL LOSS OF OIL PRESSURE	5-11
ENGINE FAILURE	5-11
IMPENDING ENGINE FAILURE	5-11
LOSS OF THRUST AFTER TAKEOFF	
(BELOW 250 KIAS)	5-11
LOW ALTITUDE LOSS OF	
THRUST/FLAMEOUT	5-12
HIGH ALTITUDE LOSS OF	
THRUST/FLAMEOUT	5-12
AIRSTART	5-12
Maximum Glide Engine Windmilling	
(Emergency Generator Extended)	5-14
PRECAUTIONARY APPROACHES	5-16
HIGH PRECAUTIONARY	
APPROACH (HPA)	5-16
FLIGHT CHARACTERISTICS WITH	
ENGINE FAILURE	5-16
Adequacy of Flight Controls	5-16
Canopy / Windshield Frosting	5-16
Glide Performance	5-16
LOW PRECAUTIONARY	
APPROACH (LPA)	5-16
Entry	5-16
Final Approach And Landing	5-19
Modified Low Precautionary Approach	5-19
STUCK THROTTLE APPROACH (STA)	5-19
Entry Procedures	5-19
Initial Point	
(Power Available for Level Flight)	5-19
Glide Slope Interception	5-20
Engine Shutdown, Final Approach	
And Landing	5-20
Initial Point	
(Insufficient Power for Level Flight)	5-20
ADDITIONAL CONSIDERATIONS	5-20
Wind Effect	5-20
High Power Approaches	5-20
Optimum Fuel Control Mode	5-20
FIRE	5-22
ENGINE FIRE	5-22
Secondary Indications of Fire	5-22
Fire Warning Light / Fire In Flight	5-22
Delayed Ejection with Engine Fire	5-23
Bleed Air Ducting Failure	5-23
WING FIRE IN FLIGHT	5-23
ELECTRICAL FIRE	5-23
SMOKE OR FUMES	5-23
Elimination of Smoke or Fumes	5-24

CHAPTER 5 (CONT.)

	PAGE		PAGE
SYSTEMS FAILURES	5-25	AIR REFUELLING STORE FAILURE	5-42
HYDRAULIC SYSTEMS FAILURE	5-25	Hose Jettison	5-42
Flight Control Hydraulic System Failure	5-25	Electrical Failure	5-42
Utility Hydraulic System Failure	5-25	Store Hydraulic Failure	5-43
Complete Hydraulics Failure	5-25	Drogue and Coupling Lost and/or	
Utility / Complete Hydraulics Failure:		Hose Severed	5-43
Landing	5-26	Loss Of Store Feathering Control	5-43
MANUAL FLIGHT CONTROL	5-26	LANDING EMERGENCIES	5-44
Performing Manual Disconnect	5-26	LANDING WITH LANDING	
Landing: Manual Flight Control	5-26	GEAR MALFUNCTIONS	5-44
Landing: Asymmetric Loading	5-26	Emergency Landing Gear Extension	5-44
ELECTRICAL SYSTEMS FAILURE	5-27	UNSAFE GEAR DOWN INDICATIONS	5-44
Main Generator Failure	5-27	Main Landing Gear Unsafe,	
Main Generator Failure: Services Affected ..	5-29	Gear Handle Down	5-44
DC-1 Converter Failure	5-29	Nose Gear Unsafe	5-48
DC-2 Converter Failure	5-29	FIELD ARRESTS	5-48
Dual Converter Failure	5-30	Short Field Arrests	5-48
Computer Interface Unit (CIU) Failure	5-31	Long Field Arrests	5-49
Display Processor (DP) Failure	5-31	Barrier Engagement	5-51
Inertial Navigation Unit Failure	5-32	LANDING : OTHER FAILURES	5-51
Digital Air Data Computer (DADC) Failure ..	5-32	No Flaps	5-51
NAS FAILURE ANNUNCIATIONS	5-33	No Speedbrakes	5-51
FLIGHT CONTROLS SYSTEMS FAILURE ..	5-36	Spoiler Malfunction On Landing Roll	5-51
Jammed Controls	5-36	Asymmetric Load	5-51
Horizontal Stabilizer Actuator Failure	5-36	No Airspeed Indication	5-51
Horizontal Stabilizer Trim Runaway		Known Brake Failure	5-51
During Flight	5-36	Brake Failure After Touch Down	5-51
Landing: Full Nose Down Trim	5-36	Nosewheel Steering Malfunction	5-51
Landing: Full Nose Up Trim	5-36	Blown Main Tyre	5-52
Normal Aileron Trim Failure	5-37	Blown Nose Tyre	5-52
Aileron Trim Runaway	5-37	Drag Chute Failure	5-52
Rudder Trim Runaway	5-37	RETRACTION RELEASE	
Spoiler Malfunction	5-37	SWITCH FAILURE	5-52
Speedbrake Failure	5-38	Ground - Remains In Airborne	5-52
AFCS MALFUNCTION	5-38	FORCED LANDINGS	5-52a
FUEL SYSTEM FAILURE	5-38	Landing On Unprepared Surfaces	5-52a
Fuel Boost Pump Failure	5-38	EMERGENCY EXIT	5-52b
Fuel Quantity Indicator Failure	5-38	Method 1	5-52a
Fuel Transfer Failure	5-39	Method 2	5-52a
Drop Tank Transfer Failure	5-39	Method 3	5-52a
Uncommanded Fuel Dumping	5-40	Emergency Entrance	5-52a
Fuel Leak	5-40	DITCHING	5-53
Fuel Leak from Fuselage Area	5-39	Ditching At Sea	5-53
Fuel Leaking from Wing Tank	5-40	Underwater Escape	5-53
Fuel Leaking from Fuselage Fuel Tank	5-41	EJECTION	5-54
ENVIRONMENTAL SYSTEM FAILURES ...	5-41	Ejection Seat Control Selector	5-61
Oxygen System Failure	5-41	Command Ejection	5-61
Hypoxia Symptoms	5-41	EJECTION PREPARATION	5-61
Air-Conditioning Temperature Control Failure	5-41	Immediate Ejection	5-61
LOSS OF CANOPY	5-41	Controlled Ejection	5-61

AL 11(8)

CHAPTER 5 (CONT.)

	PAGE		PAGE
EJECTION INITIATION	5-64	No 1 Mk 2 Signal Distress Day and Night ...	5-80
Lower Handle	5-64	AN/URT-33A Radio Beacon Set	5-81
Face Curtain	5-64	Becker MR509 Personal Locator Beacon ...	5-81
Canopy Fails To Jettison	5-65	<i>Activation Sequence</i>	5-82
EJECTION SEQUENCE	5-65	<i>Survivor Confidence Check</i>	5-82
AUTOMATIC SEAT/PILOT SEPARATION ...	5-71	<i>Voice Communication</i>	5-83
MANUAL SEAT/PILOT SEPARATION	5-71	<i>Externally Activated</i>	
MANUAL BAILOUT	5-72	<i>Voice Communication</i>	5-83
POST-EJECTION PROCEDURES	5-72	<i>Operation with Integral Antenna</i>	5-83
OPTIONS	5-75	RESCUE	5-84
LANDING PREPARATION OVER WATER ...	5-77	DESCENT OVER LAND	5-85
Parachute Release Procedure	5-77	Landing Preparation Over Land	5-85
RAFT BOARDING	5-78	PERSONNEL LOWERING DEVICE	
SIGNALLING DEVICES	5-79	(TREESCAPE)	5-86
Signal Distress Kit	5-79	Description	5-86
SDU-5/E Distress Marker Light	5-80	Operation	5-87
Emergency Signalling Mirror	5-80		

FIGURES

FIGURE	PAGE	FIGURE	PAGE
5-1 Summary of Flameout Action	5-13	5-25 Remove Mask	5-74
5-2 Engine Relight Envelope	5-15	5-26 Remove Koch Fitting Pins	5-74
5-3 Maximum Glide	5-15	5-27 Remove RSSK8 QRB Pin	5-74
5-4 High Precautionary Approach	5-17	5-28 Inflate LSV	5-75
5-5 Low Precautionary Approach	5-18	5-29 Deploy RSSK8 Survival Kit	5-75
5-6 Stuck Throttle Approach		5-30 Raise Visor	5-75
(Sufficient Power for Level Flight)	5-21	5-31 Discard Oxygen Mask	5-76
5-7 Typical CG Travel: Gear and		5-32 Operate 4 Line Release Handles	5-76
Flaps Down	5-37	5-33 Turn Into Wind	5-76
5-8 Unsafe Gear	5-46	5-34 Preparation For Water Entry	5-77
5-9 Terrain Clearance for Safe Ejection		5-35 Release Parachute On Entering Water ..	5-77
ESCAPAC 1G-3 Ejection Seat	5-55	5-36 Attach Lanyard To Raft	5-78
5-10 Ejection Seat Control Selector	5-61	5-37 Release Seat Kit	5-78
5-11 Check Altitude	5-62	5-38 Board Raft	5-78
5-12 Ejection Body Position	5-62	5-39 Sitting Position In Raft	5-78
5-13 Ejection Injuries and Body Positioning .	5-63	5-40 Retrieve Survival Pack	5-78
5-14 Lower Ejection Handle Grip	5-64	5-41 Retrieve URT-33	5-79
5-15 Face Curtain Handle Grip	5-64	5-42 Canopy Inflation	5-79
5-16 Ejection Sequence ESCAPAC 1G-3		5-43 Signal Distress Kit	5-79
Ejection Seat	5-66	5-44 Hold Well Clear When Firing	5-79
5-17 Ground Level Ejection -		5-45 Distress Marker Light	5-80
ESCAPAC 1G-3 Ejection Seat	5-68	5-46 Use Of Emergency Signalling Mirror ...	5-80
5-18 Low Speed Ejection -		5-47 Smoke and Illumination Signal	5-80
ESCAPAC 1G-3 Ejection Seat	5-69	5-48 AN/URT-33A Beacon	5-81
5-19 High Speed Ejection -		5-49 MR509 PLB -	
ESCAPAC 1G Ejection Seat	5-70	Controls and Indicators	5-81
5-20 Squeeze Manual Seat		5-50 MR509 PLB - Operation	
Separation Handle Trigger	5-71	with Integral Antenna	5-83
5-21 Operate Emergency Restraint Release ..	5-71	5-51 Becker MR509 PLB	5-84
5-22 Push Seat Away	5-72	5-52 Stay In The Raft	5-84
5-23 Locate And Operate Ripcord	5-72		
5-24 Check Parachute	5-74		

CHAPTER 5 (CONT.)

FIGURE	PAGE	FIGURE	PAGE
5-53 Secure Rescue Strop And Disconnect Lanyard	5-84	5-57 Roll to Sides of Calves	5-86
5-54 Thumbs Up To Helo	5-84	5-58 Continue to Roll onto Thighs and Buttocks	5-86
5-55 Release Kit Using QRB	5-85	5-59 Lowering Lanyard Stowage	5-86
5-56 Body Position For Landing	5-85	5-60 Treescape Lowering Device	5-87

TABLES

TABLE	PAGE	TABLE	PAGE
5-1 Rate Of Descent – Flameout	5-16	5-9 Services Inoperative With INU Failure	5-32
5-2 Services Available On RAT	5-28	5-10 Services Inoperative With DADC Failure	5-33
5-3 Services Inoperative On The RAT	5-29	5-11 Fault Annunciations and Required Actions	5-34
5-4 Services Inoperative When Horizontal Stab Operated	5-29	5-12 Emergency Landing With Gear Malfunctions	5-47
5-5 Services Inoperative With DC-2 Failure	5-30	5-13 Fire Crew Signals	5-49
5-6 Additional Services Inoperative With A Dual Converter Failure	5-30	5-14 Emergency Arrest Data	5-50
5-7 Services Inoperative With CIU Failure ..	5-31	5-15 Summary Of Actions	5-73
5-8 Services Inoperative With DP Failure ...	5-32	5-16 MR509 PLB – Description and Function of Controls and Indicators	5-82

AL 8(7)

CHAPTER 5

EMERGENCY PROCEDURES

GENERAL

5.1 This section contains the specific procedures to be used for emergencies likely to be encountered in the aircraft. Other sections of this manual must be used to provide specific information on system operation. Because of varied conditions such as compounded emergencies, available facilities, and weather factors, it is likely that most emergencies will require some deviation from the procedure set forth for a simple failure. Consequently, thoughtful analysis of each situation is necessary, and the

selection of the course of action to be taken rests with the pilot.

NOTE

Items that are asterisked are considered “**Boldface**” or immediate action items, which the pilot must be able to perform without reference to this manual or a pocket checklist.

GROUND EMERGENCIES

ABNORMAL STARTS

Hung, Hot or Wet Start

5.2 Procedure.

- 1.* Throttle OFF
- 2.* Starter Air CONTINUE

Hung Start

5.3 A hung start occurs when the engine appears to light off normally, but the RPM stabilizes at some point below idle, (usually 40 to 45 percent), and EGT continues to rise toward maximum temperature limits. Proceed as above and continue windmilling the engine to cool the turbine section and clear the engine.

5.4 Before attempting another start, determine that the compressor/turbine components are turning freely. If the second start attempt results in a hung start, a thorough investigation must be made to determine the cause.

Hot Start

5.5 A hot start is a start during which the EGT exceeds 455°C. If the starting limit seems likely to be exceeded, proceed as above.

CAUTION

If engine EGT exceeds 455°C five times, or reaches 531°C to 565°C for one period of 5 seconds or more, the engine must be subjected to an overtemperature inspection. An EGT exceeding 565°C for any period of time will require a teardown inspection of all hot section parts.

NOTE

If the EGT is rising rapidly through 340°C the start limit will probably be exceeded. Log duration and peak temperature for each start during which EGT exceeds 455°C.

Wet Start

5.6 A wet start occurs when the engine light off is not obtained (EGT fails to rise) within 20 seconds of advancing the throttle and fuel vapour is emitting from the tailpipe. Proceed as above.

CAUTION

Be careful not to actuate the igniters as the throttle is moved to OFF.

Upon experiencing a wet start, determine that no residual fuel remains in the combustion chamber or tailpipe before attempting another start. If residual fuel is evident and a period of time has elapsed, a close inspection must be made to ensure that no fuel has seeped under tailpipe heat blanket or into the drag chute housing before a restart is attempted.

NOTE

If necessary, replace the drag chute.

AL 8(7)

False Start

5.7 A false start occurs when the engine lights off normally and EGT remains in limits, but the RPM remains at some RPM below idle for 120 seconds or more. If a false start occurs:

- 1.* Throttle OFF
- 2.* Starter Air OFF
3. Investigate prior to restart.

ENGINE FIRE DURING START/SHUTDOWN

5.8 Procedure.

- 1.* Throttle OFF
- 2.* Manual fuel shutoff EMER OFF
- 3.* Starter Air CONTINUE
4. Motor engine in an attempt to blow out the fire.
If fire persists:
5. Abandon aircraft

WING OR ACCESSORY SECTION FIRE

5.9 Procedure.

- 1.* Throttle OFF
- 2.* Manual fuel shutoff EMER OFF
- 3.* Starter air OFF
- 4.* Electrical power OFF
5. Abandon aircraft

BRAKE FAILURE DURING TAXI

5.10 Procedure.

- 1.* Nosewheel steering ENGAGE
- 2.* Hook DOWN
3. In event of single brake failure, use remaining brake and nosewheel steering to maintain directional control and to stop aircraft. Groundloop if necessary to remain on the sealed surface.

4. Throttle OFF

NOTE

Pumping brakes vigorously may recover partial brake pressure.

5. Retract landing gear only as last resort to stop aircraft.

NOTE

The landing gear handle safety solenoid must be actuated manually to move handle to UP position.

HOT BRAKES

5.11 When excessive braking has occurred (such as after an aborted takeoff), or hot brakes are suspected, notify the tower to alert the crash crew and to inform other personnel to stand clear. A dragging brake will also produce excessive heat at the wheel. In each case, the amount of heat will vary. A badly dragging brake (indicated by higher than normal power settings to maintain taxi speed) could raise wheel temperatures to a point where a normal takeoff would heat the wheel enough to produce an explosive failure.

5.12 Any time an aircraft has aborted takeoff at high speed, or has suspected hot brakes, carryout the following procedure:

1. Advise Air Traffic Control and Squadron Operations/Maintenance Flight.
2. Proceed to the designated hot brakes area, ORP or a clear area.
3. Park the aircraft so that the wheel axles point toward a clear area.
4. Chock nose wheel.
5. Shut down aircraft.
6. Allow a minimum of 45 minutes for brakes to cool prior to moving.

NOTE

Unless operational necessity dictates otherwise, do not attempt to get airborne with a dragging brake. If a takeoff is completed, leave the landing gear extended for at least 3 minutes to cool the brake unit.

AL 8(7)

TAKEOFF EMERGENCIES

ENGINE FAILURE DURING TAKEOFF ROLL

5.13 Procedure.

- 1.* Throttle CHECK FULL FORWARD

If the engine fails to respond:

- 2.* ABORT if possible.
3.* EJECT if unable to abort.

NOSEWHEEL STEERING MALFUNCTION

5.14 Nosewheel steering shall not be used for takeoff and landing, unless directional control is lost. If a nosewheel steering malfunction is suspected:

1. Ensure nosewheel steering switch is in NORM position.
2. Centralize rudder pedals.
3. Actuate stick control button in an attempt to maintain directional control.
If pressing stick control button is ineffective:
4. Release stick control button.
5. Maintain directional control with rudder and brakes.
6. Place nosewheel steering switch to EMER OFF.

RUNAWAY NOSEUP TRIM/NOSE PITCH UP ON TAKEOFF

5.15 With runaway noseup trim, excessive pitch up will be encountered as the aircraft accelerates through 170 KIAS and the flaps are raised. Full forward stick will not provide sufficient nose down authority to override the horizontal stabilizer when trimmed to the full nose up position. Should this situation be encountered, proceed as follows:

Below Refusal Speed:

- 1.* ABORT

Above Refusal Speed:

- 2.* Flaps FULL DOWN
3.* Airspeed MINIMUM SAFE
4.* Manual Trim Override ... NOSE DOWN
5.* External Stores JETTISON
(IF REQUIRED)
6.* RAT DEPLOY (IF REQUIRED)
7. Burn down and land.

WARNING

Should the angle of attack approach the stall, altitude loss and sink rate may develop to a point that may preclude a safe ejection.

8. Refer to LANDING WITH FULL NOSE UP TRIM, page 5-36.

RUNAWAY NOSEDOWN TRIM

5.16 Procedure.

Below refusal speed:

- 1.* ABORT

Above refusal speed:

- 2.* Flaps UP
3.* Manual Trim Override NOSE UP
4.* External stores JETTISON
(IF REQUIRED)
5.* RAT DEPLOY (IF REQUIRED)

WARNING

If unable to rotate the nose to a takeoff attitude 5 knots below the predicted takeoff airspeed, the pilot must decide whether to abort, apply corrective noseup trim (using the manual override), or eject. Ejection is recommended before leaving the runway surface at very high speed.

AL 8(7)

NOTE

Raising the flaps will change the angle of attack of the wing slightly and increase the probability of achieving enough rotation to become airborne.

6. Refer to **LANDING WITH FULL NOSE DOWN TRIM**, page 5-36.

Inadvertent Flight Control Disconnect

5.17 If a flight control disconnect has occurred, greater than normal stick forces will be required to counter the positive pitching moment at takeoff. Leave flaps down to reduce trim changes and use longitudinal trim, as required, to control the aircraft. Do not let angle of attack get too high. Comply with the procedures for a flight control disconnect.

CAUTION

The flight control hydraulic system must not be disconnected with a hydraulic system functioning if the flight controls appear to be jammed or malfunctioning.

ABORTING TAKEOFF

5.18 There are many circumstances that may require aborting a takeoff. Some examples are as follows:

- Less than normal EPR/EGT/RPM
- Fire warning light
- Runaway nosedown trim
- Slower than normal aircraft acceleration
- Smoke in the cockpit
- Blown tyre
- Loss of canopy
- Hazard on the runway
- Loss of oil pressure
- Dragging brake
- Uncommanded swerving

5.19 The decision to abort or continue the takeoff must be based on the nature of the malfunction, aircraft speed, wind component, runway remaining, arrest facilities, and whether or not the aircraft can become airborne prior to leaving the runway. A takeoff abort shall be accomplished by use of arrestor gear when available, unless it is certain the aircraft will be stopped or slowed to taxi speed by normal braking on the runway remaining. If there is no arrestor gear then the decision to abort must be made prior to exceeding takeoff refusal speed.

- 1.* **Throttle** **IDLE**

NOTE

Best deceleration will occur by placing the throttle to IDLE until below 80 KIAS and then by placing the throttle to OFF.

- 2.* **Speedbrakes** **OPEN**
 3.* **Drag Chute** **DEPLOY**
 4.* **Braking** **AS REQUIRED**

NOTE

Do not blow the tyres. Maximum braking is required at takeoff refusal speed. For maximum braking apply full forward stick, with into wind aileron, followed immediately by moderately heavy application of brake pedal pressure. Maintain steady braking throughout the rollout to a stop or desired taxi speed, increasing brake pedal pressure as the rollout speed decreases.

- 5.* **Hook down** .. **1,000 FT PRIOR TO THE ARRESTOR GEAR IF REQUIRED.**

WARNING

If off centre just prior to engaging arrestor gear, do not attempt to go for centre of runway. Track straight ahead parallel to runway centreline.

Rudder pedals must be centred prior to engaging nosewheel steering to prevent excessive nosewheel steering inputs which could lead to loss of control.

NOTE

Nosewheel steering may be used to keep the aircraft lined up with runway centreline. If aircraft engine is secured, nosewheel steering will immediately become inoperative due to loss of electrical power.

6. Stick forward and into wind.
 7. Simultaneously with the above steps transmit an abort call.

AL 8(7)

8. If aborting after exceeding takeoff refusal speed where abort gear is not available or if the hook skips the arrestor gear, decide whether to remain with the aircraft, or EJECT.

NOTE

The decision to eject if the aircraft is leaving the runway or overrun must be made with consideration to speed and the nature of the surface onto which the aircraft will go.

BLOWN TYRE ON TAKEOFF

- 5.20 Abort, if possible. If unable to abort:

1. Leave gear down. (If operational necessity dictates continuation of the mission, leave gear down for 3 minutes prior to raising).
2. Obtain visual check.
3. LASAPRAC.

NOTE

The braking effectiveness of a blown tyre is much reduced. Consequently, to deliberately blow a good tyre to balance another that is blown is not good practice.

4. Short Field Arrest is recommended. Refer **LANDING: BLOWN TYRE**, page 5-52.

RETRACTION RELEASE SWITCH: AIRBORNE - MALFUNCTIONS TO GROUND

5.21 Retraction release switch failure prevents the under carriage handle from being moved to the UP position. This may result from a dual converter failure, microswitch malfunction, or failure of the left main oleo to fully extend.

1. Leave the gear down.
2. Dump/burn down and land.

If operational necessity dictates the requirement to raise the gear with the retraction release switch inoperative:

3. Obtain visual check of main landing gear mounts to ensure proper strut extension.

CAUTION

The retraction release switch may fail to function if the left main gear is not fully extended. If an attempt is made to raise landing gear when this occurs, the tyre and wheel assembly may hang up, resulting in a wheels up landing.

4. Move downlock release latch aft and simultaneously raise gear handle to full UP position.

- 5.22 The following equipment will be unavailable:

RRSS-Fail to Ground - Equipment Unavailable

AFCS and Stab Aug	Radar
Chaff/Flare Dispenser	IFF Mode 4
Weapon Release	Elapsed Time
RWR Alt Blanking	AoA Indexers/Transducer Heat

WARNING

Spoilers will open if armed and throttle reduced below 70%. The Park Brakes will hold if selected.

UNSAFE GEAR-UP INDICATION

- 5.23 Nose or Main Gear Unsafe or down, Gear Handle Up:

1. Maintain 225 KIAS or less.
2. Obtain visual inspection if possible.

If the gear door is closed:

3. Slow aircraft to minimum safe airspeed to increase AOA, and reduce aircraft G loading with a slight bunt if required. (Relative Airflow and reduced G assist the door to lock up). Continue the mission if the gear indicates up.

If unable to get visual check or if visual check indicates that gear is not fully retracted or that wheel door is not fully closed, proceed as follows:

4. Lower gear (do not cycle).

NOTE

If gear will not lower, problem may be caused by insufficient oleo extension of left main gear. Check for signs of retraction release failure. Attempt to establish whether gear is sufficiently clear of obstructions in aft wheel well before moving downlock release latch aft and lowering gear handle. If this is unsuccessful, refer Landing With Landing Gear Malfunctions.

5. Obtain a locked down indication.
6. Dump or burn excess fuel.
7. LASAPRAC.

HANDLING EMERGENCIES

DEPARTURE FROM CONTROLLED FLIGHT

5.24 Procedure.

- 1.* Control Column CENTRAL TO SLIGHTLY AFT
- 2.* Harness LOCKED
- 3.* Throttle BELOW 80 %
- 4.* Trim 0 - 4° NOSE UP
- 5.* Flaps/speedbrakes UP/IN
- 6.* Altitude If out of control passing 10,000 feet AGL, EJECT.

WARNING

The rudder and ailerons should be centralised immediately upon departure from controlled flight. The elevator should be positioned and visually verified slightly aft of the neutral position. The use of both hands is recommended.

A stabilizer setting greater than 6° nose up or less than zero is the same as intentionally holding aft or forward stick during post stall gyrations. The slightly aft stick position for recovery is dependent upon proper setting of the stabilizer trim. Failure to set the trim between 0° and 4° noseup can delay or prevent recovery.

5.25 Random yaw and roll oscillations associated with out of control flight must be accepted. Intentional or inadvertent control inputs will increase roll and yaw, prolonging the loss of control and significantly increase the possibility of spin entry.

5.26 If controlled flight is not regained, check HUD and ADI instruments for spin indications of:

- 7.* AOA Max scale (upright)
Min scale (inverted).
- 8.* Low airspeed 50 to 150 KIAS.

- 9.* Turn needle PEGGED
(Indicates direction of spin)

WARNING

Under certain oscillatory conditions, the CIU may disregard the DADC output, resulting in AoA, altitude and airspeed information being blanked from the HUD. Therefore AoA information may not be available, or may be unreliable. If blanked from the HUD, altitude and airspeed should be obtained head-down.

SPIN RECOVERY

WARNING

The high rates of change of air data to the DADC during a spin may cause momentary blanking of altitude, airspeed and AoA information in the HUD.

5.27 Once spin mode and direction have been positively identified, proceed as follows:

CAUTION

The first step in any spin recovery is to neutralize the controls and determine if the aircraft is really spinning. Do not be hasty in applying recovery controls; the spin is likely to stop while maintaining the controls neutral.

Upright Spin Recovery

5.28 Procedure.

- 1.* Aileron FULL INTO turn needle.
- 2.* Rudder . FULL OPPOSITE turn needle.
- 3.* Elevator CENTRAL to slightly aft.

CAUTION

Spin recovery controls must be applied smoothly.

AL 8(7)

4.* Controls CENTRALISE
when rotation stops.

5.* 200 KIAS 18 – 20 unit pullout.

If in the unlikely event the aircraft fails to recover:

6.* Drag chute DEPLOY

7.* If out of control passing 10,000 feet AGL,
EJECT.

WARNING

If the spin occurs below 10,000 ft AGL and neutralizing flight controls does not result in prompt recovery, EJECT. Recovery from a fully developed spin below 10,000 ft AGL is considered doubtful.

Ejection must not be delayed due to the extremely high rates of descent (22,000 to 35,000 fpm).

NOTE

With proper recovery controls maintained, recovery from a fully developed spin may require up to three turns if erect and up to four turns if inverted. The ailerons are the most powerful recovery control and must be applied properly to recover from a spin.

Inverted Spin Recovery

5.29 Procedure.

- 1.* Aileron . FULL OPPOSITE turn needle.
- 2.* Rudder . FULL OPPOSITE turn needle.
- 3.* Elevator CENTRAL to slightly aft.

CAUTION

Location of stick neutral point may be extremely difficult to determine since up to 20 pounds of stick pull force may be required to keep the stick centred during inverted spin recovery. A cockpit reference point should be determined for neutral positioning prior to flight.

Spin recovery controls must be applied smoothly.

4.* Controls CENTRALISE passing
200 KIAS

CAUTION

It is imperative that the pilot maintain anti-spin controls as the aircraft rolls upright during the hesitant inverted mode. It may appear that the aircraft is recovering from the spin; however, increasing airspeed is the surest indication that recovery is effected and that the aircraft will not re-enter the spin.

5.* 200 KIAS 18 – 20 unit pullout.

If in the unlikely event the aircraft fails to recover:

6.* Drag chute DEPLOY

7.* If out of control passing 10,000 feet AGL,
EJECT.

ASYMMETRIC SLAT DEPLOYMENT

5.30 Expect a roll away from the extended slat:

1. Relax G (slat should retract).
2. Use rudder and aileron to counter roll.

NOTE

Abrupt, large aileron inputs to counter roll can induce adverse yaw and increases spin susceptibility.

Slat Lockout

5.31 If one or both slats stick in the extended position:

1. Relax G.
2. If slat(s) remain extended, slow to 200–250 KIAS; slat(s) should retract and function normally.
3. If necessary, induce small pitch oscillations to retract slat(s).
4. If slat(s) will not retract, remain below 200 KIAS, and land as soon as practicable.
5. Fly optimum AoA approach. (If AoA not available, add 10 KIAS to normal approach speed). Large but controllable rolling movement will occur, should the slat extend during the approach.
6. Trim out adverse lateral control pressure. Be alert for prompt correction if slat extends.

AL 8

7. Make normal touchdown. DO NOT FLARE.

WARNING

Do not exceed 19 units AOA in an asymmetric slat condition. Be prepared to counter uncommanded roll with rudder/aileron if one slat suddenly functions normally during approach.

CAUTION

Performing a flared approach may cause the slat to extend, resulting in uncommanded roll rates in a critical phase of flight.

AL 8

INTENTIONALLY BLANK

MIDAIR/BIRDSTRIKE/COMBAT STRUCTURAL FAILURE OR DAMAGE

5.32 Loss of structural integrity may result from midair collision, exceeding structural limits, bird strikes, etc. The following procedures generally apply:

1. If at low altitude, commence zoom climb. **REDUCE AIRSPEED.**
2. Leave throttle as set.
3. Determine whether adequate control of aircraft is available for continued flight. If not, **EJECT.**
4. If able to control aircraft, **CLIMB** to minimum recommended ejection altitude (10,000 feet AGL or above) at reduced airspeed to prevent further damage.
5. If it is suspected that FOD may have entered the engine, use **MINIMUM POWER** to maintain level or a slow climb.
6. Obtain visual inspection, if available.
7. Conduct slow speed handling check in landing configuration at 10,000 feet AGL, or above.
8. Lower flaps in increments to determine if split flap condition exists. Do not stall.
9. **LASAPRAC.** Make **LPA**, modified as necessary, unless the damage is determined to be negligible. Refer **LPA**, page 5-16 and Figure 5-5.

NOTE

If a bird has been ingested into the engine, even though there is no visible damage or indications of engine malfunctions, prompt landing should be made, since possibility exists that the engine may seize. Assume that the bird has been ingested if it strikes the side of fuselage forward of engine intake ducts.

AL 8(7)

ENGINE MALFUNCTIONS

CHUGS AND STALLS

5.33 Procedure

- 1.* **RPM** **REDUCE**
If stalls continue:
2. **AoA** **DECREASE IF POSSIBLE**
3. **Airspeed** **INCREASE IF POSSIBLE**
If icing suspected:
4. **Anti-ice** **ALL**
5. **Descend below freezing level.**
If icing not suspected:
6. **Fuel control** **MANUAL**
If stalls continue:
7. **Throttle** **OFF**
8. **AIRSTART**
If stalls clear:
9. **Check for adverse symptoms** . . **LASAPRAC**

NOTE

Removal of the airspeed cut out switch, modifications to the bleed valves on the J-52 and adjustments which determine the ratio at which the bleed valve opens, ensures the bleed valve may open at any stage when the N1 compressor loading dictates. The modifications have blanked many of the bleed valve ports which leaves only four remaining. The cycling of the remaining bleed valve ports, when required to do so, may result in light hunting.

RPM/EGT MALFUNCTIONS

5.34 Fluctuating RPM not corresponding to similar indications of fuel flow, EPR, or EGT should be assumed to be a faulty tachometer system. Use airspeed and throttle position for power reference if RPM is unreadable. If fuel flow or EGT is also fluctuating, assume a **PRIMARY** fuel control malfunction and shift to **MANUAL**.

5.35 Fuel flowmeter, EGT or EPR fluctuations should be treated similarly; unless engine performance is determined to be erratic from more than one source, assume an instrument error. Otherwise shift to **MANUAL** fuel control.

NOTE

Fuel flow fluctuations of up to 200 pph may occur due to instability of the speed governor. This will generally be accompanied by fluctuations of EPR of approximately 0.1 and of RPM of approximately 1 percent. The J52 normally exhibits very stable operating parameters, and therefore any transient indications should be treated with suspicion and the aircraft recovered as soon as practicable for further investigation.

ENGINE OVERTEMPING

5.36 During climbs or sustained operations at **MILITARY** power, minor engine overtemping (5°C or less) may occur. This overtemping should be controlled by reducing RPM slightly to maintain EGT within limits. If overtemping recurs at the reduced RPM or is in excess of 5°C, land at the nearest suitable landing facility as soon as possible unless other action is indicated.

AL 8(7)

THROTTLE LINKAGE FAILURE

5.37 No provisions are incorporated for automatic positioning of the fuel control if throttle linkage failure occurs. The engine may accelerate to MILITARY, remain as is, retard to IDLE, or flameout. Once determined that throttle linkage failure exists, proceed as follows:

1. DO NOT manipulate throttle.
2. Determine the thrust available. Be alert for slow RPM decay. Consider use of MANUAL fuel control if RPM is at maximum or minimum extremes.
3. Fly STA or LPA approach, maintaining 180 KIAS minimum. Refer to page 5-19 and Figure 5-6 for STA procedures. Refer to page 5-16 and Figure 5-5 for LPA procedures.

When a landing is assured:

4. Manual Fuel Shutoff EMERG OFF

STUCK THROTTLE

5.38 Outboard movement of the throttle from the idle position may result in contact with the lip on the console lever guide slot at the lower end of the normal operating range preventing forward throttle movement. The restriction in forward throttle movement corresponds to 75-80% inflight RPM. When the throttle cannot be moved even with inboard pressure, refer STA page 5-19 and Figure 5-6.

FUEL CONTROL MALFUNCTIONS

5.39 A malfunction of the fuel control unit may result in fluctuating RPM and EGT, a sudden drop in fuel flow indication, or a complete loss of power. When any of these occur, proceed as follows:

1. Throttle MATCH WITH RPM
2. Fuel Control Switch MANUAL
3. Slowly advance throttle to desired setting.

CAUTION

Do not reset fuel control to PRIMARY after airstart unless flameout is known to have been caused by reasons other than engine fuel system malfunction.

Operate throttle cautiously so as not to exceed RPM and temperature limitations when operating in MANUAL.

If a shift from MANUAL to PRIMARY is made, perform the shift between 80 to 85 percent RPM in order to minimize the risk of flameout.

ENGINE DRIVEN FUEL PUMP

5.40 When the engine-driven fuel pump fails, a flameout will occur, and no relight is possible. Failure of the engine-driven fuel pump is indicated by zero fuel flow.

AL 8(7)

OIL SYSTEM MALFUNCTIONS

HIGH OIL PRESSURE (OVER 50 PSI)

5.41 Procedure.

1. Throttle REDUCE AS REQUIRED
2. Oil quantity MONITOR
3. LASAPRAC
4. If 20% oil light illuminates, follow low oil quantity procedures.

CAUTION

Oil pressure above 50 psi can cause failure of the internal oil seals and result in loss of oil to the engine.

LOW OIL QUANTITY/PRESSURE

5.42 Procedure.

1. RPM 86-88%

2. LASAPOSS VIA LPA OR
MODIFIED LPA

After landing

3. Throttle OFF

NOTE

Manoeuvres producing acceleration near zero G may cause a temporary loss of oil pressure. Absence of oil pressure is permissible for a maximum of 10 seconds.

TOTAL LOSS OF OIL PRESSURE

5.43 In the event of total loss of oil pressure, experience has shown that the engine will remain running for approximately 5 to 8 minutes at 86-88% RPM.

5.44 Increased engine friction may prevent the engine from accelerating once the throttle has been retarded and with a bearing failure, operation at very low power settings may hasten engine seizure. If severe vibrations and RPM roll back occurs, engine failure is imminent.

ENGINE FAILURE

IMPENDING ENGINE FAILURE

5.45 Symptoms of imminent engine failure, singly or in combination, are:

1. Loss of thrust, not due to throttle movement or icing.
2. Fluctuating RPM, EGT, and EPR not eliminated by shifting to MANUAL fuel control.
3. Abnormally high EGT in relation to engine RPM.
4. Oil pressure dropping or less than 40 psi.
5. Abnormal vibration or loud or explosive sounds apparently emanating from the engine.

5.46 If any of the above symptoms appear:

- 1.* Throttle AS REQUIRED
- 2.* LASAPOSS ... VIA PRECAUTIONARY
APPROACH

LOSS OF THRUST AFTER TAKE-OFF (BELOW 250 KIAS)

5.47 If possible, land straight ahead on remaining runway. If insufficient runway is available:

- 1.* Throttle CHECK FULL FORWARD
- 2.* ZOOM CLIMB
- 3.* If speed cannot be maintained ... EJECT
If unable to eject, accomplish as many of the following as possible:
4. Throttle OFF
5. Landing Gear UP
6. Manual Fuel Shutoff EMER OFF
7. Land straight ahead.

AL 8(7)

LOW ALTITUDE LOSS OF THRUST/FLAMEOUT

5.48 When loss of thrust occurs under low altitude/high airspeed conditions, the following procedure is recommended:

- 1.* Throttle CHECK FULL FORWARD
- 2.* ZOOM CLIMB.
- 3.* If below 1,500 ft AGL and EJECT 250 KIAS
- 4.* Throttle RETARD

NOTE

The engine may run at some reduced thrust setting if the throttle is retarded to a point at which the engine is "caught" before flameout.

- 5.* Fuel Control switch MANUAL

NOTE

Selecting MANUAL fuel prior to loss of electrical power may prevent flameout.

5.49 If thrust is not regained immediately, proceed as follows:

- 1.* RAT DEPLOY
- 2.* Throttle IGNITION, THEN IDLE
3. Monitor EGT for signs of relight.
- 4.* External Stores JETTISON IF REQUIRED
- 5.* Throttle CAUTIOUSLY ADVANCE
- 6.* Below 5,000 feet AGL NIL ENGINE RESPONSE, EJECT
- 7.* Above 5,000 feet AGL AIRSTART
If time and altitude permit, establish 250 Kts glide and commence airstart.

HIGH ALTITUDE LOSS OF THRUST/FLAMEOUT

5.50 Procedure.

- 1.* Throttle CHECK POSITION

WARNING

When selecting throttle to IDLE, especially in conjunction with deployment of speedbrakes, extreme care must be taken to avoid application of outboard pressure on the throttle. This action will prevent inadvertent selection of throttle to OFF and subsequent engine flameout.

If icing is suspected, remain in PRIMARY, reduce power setting and change altitude.

- 2.* Anti-icing ALL
If no icing is suspected:
- 3.* Fuel control switch MANUAL
If flameout occurs:
4. AIRSTART

NOTE

Selecting manual fuel prior to loss of electrical power may prevent flameout.

AIRSTART

5.51 Procedure.

- 1.* RAT DEPLOY
- 2.* Throttle OFF

WARNING

If fire is present or existed prior to shutdown do not attempt to restart the engine.

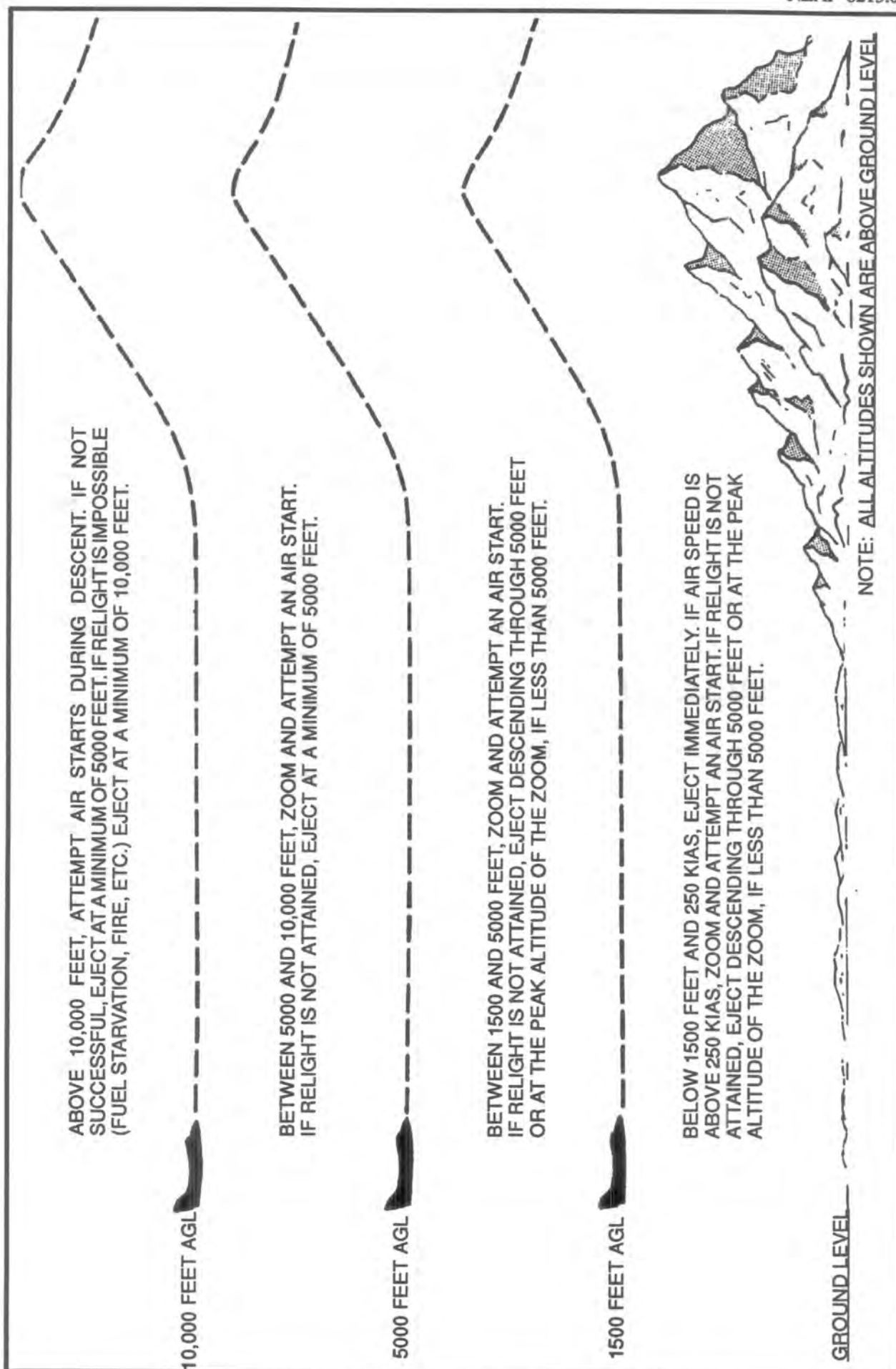


Figure 5-1 Summary of Flameout Action

AL 8(7)

5.52 If no fire exists, proceed with airstart as follows:

NOTE

Successful airstarts can be obtained at any airspeed and altitude combination within the envelope prescribed in Figure 5-2. However, for best relight capabilities descend to 30,000 ft or below at IAS for max gliding range.

Unless fuel control malfunction exists, airstarts may be made with PRIMARY fuel control selected.

Avoid negative G flight to prevent air being trapped in the engine driven fuel pump inlet and to minimize fire hazard.

Ensure emergency generator bypass switch is in NORMAL position.

3.* Glide 250 KIAS

4.* Throttle IGN, THEN IDLE

5.* External Stores JETTISON IF
REQUIRED

CAUTION

If relight was made in manual fuel control, do not reset fuel control to primary after airstart. Operate throttle cautiously to avoid exceeding RPM and EGT limits.

NOTE

Absence of fuel flow after moving the throttle from the OFF position is an indication that airstart is impossible.

Below 250 KIAS in manual fuel control, metering of fuel flow with the throttle open is required. Optimum relight range of fuel flow is 500 to 850 pph. JP-4 lights more readily at lower part of fuel flow range, JP-5 at higher part.

6.* Fuel Flow. 500-850 pph

7.* RPM, EGT, Fuel Flow MONITOR
30-45 SECS

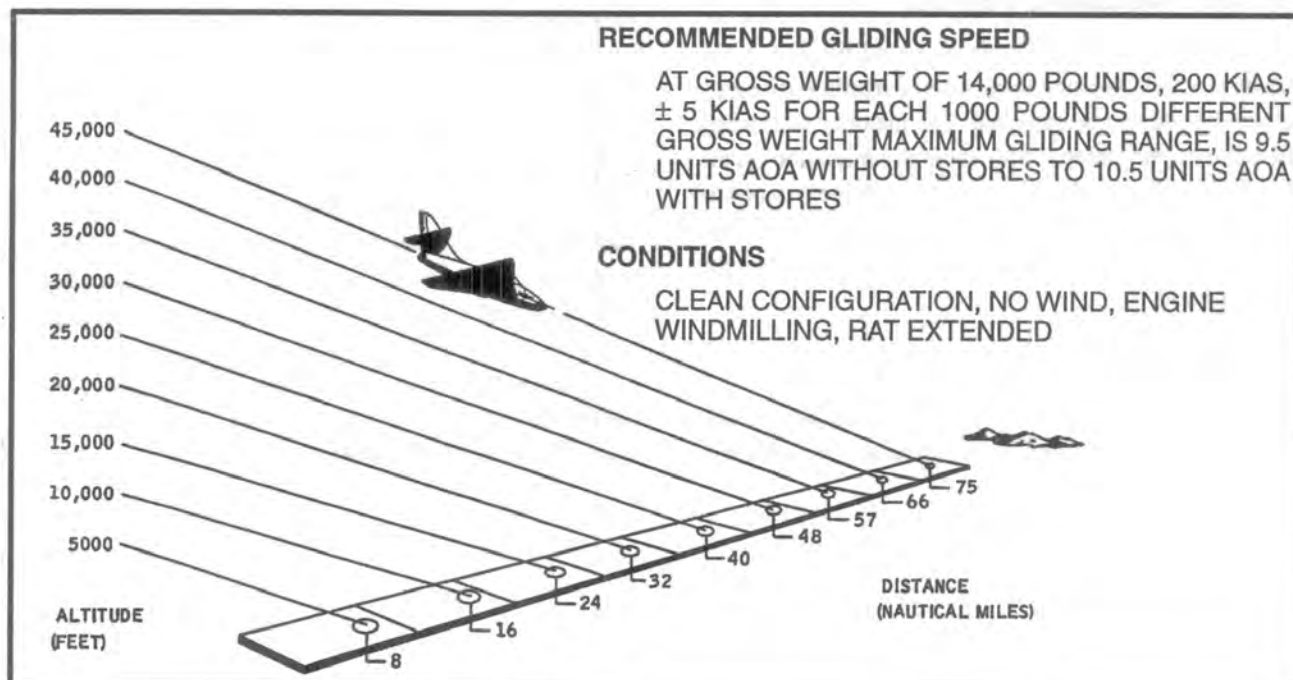
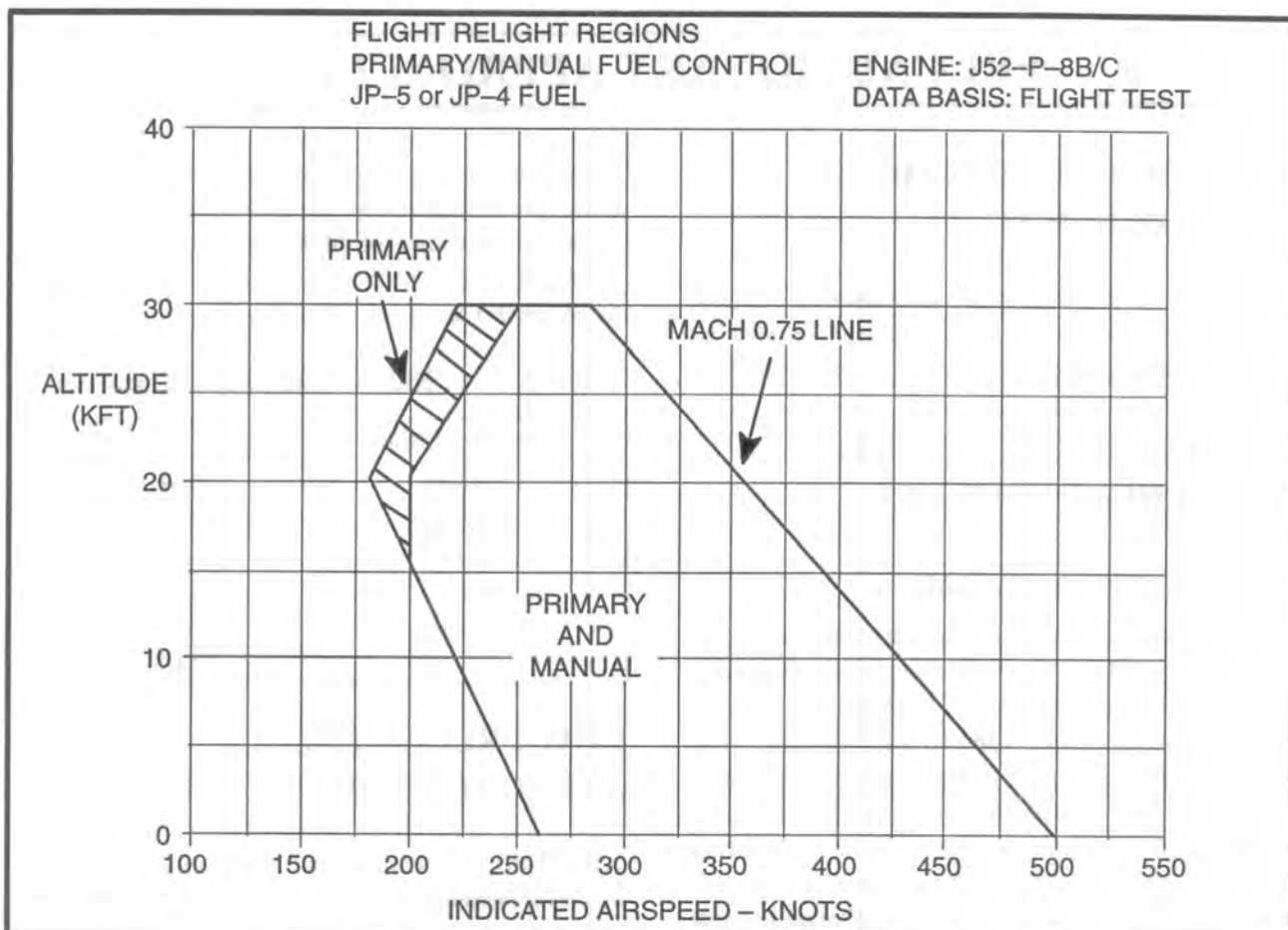
If relight does not occur within 30-45 seconds, and time and altitude permit:

8. Throttle IGN, THEN IDLE

Maximum Glide Engine Windmilling (Emergency Generator Extended)

5.53 The recommended speed for maximum gliding range is approximately 200 KIAS for gross weights up to 14,000 pounds, clean configuration, and altitudes up to 45,000 feet. For each 1000 pound increase over 14,000 pounds, increase airspeed by 5 knots. The maximum gliding range angle of attack is 9.5 units without stores and 10.5 units with wing stores. See Figure 5-3 for approximate ranges from various altitudes.

AL 7(0)



PRECAUTIONARY APPROACHES

HIGH PRECAUTIONARY APPROACH (HPA)

5.54 If it is impossible to eject/abandon aircraft following a flameout, an HPA and landing may be attempted utilizing the procedures depicted in Figure 5-4.

FLIGHT CHARACTERISTICS WITH ENGINE FAILURE

Adequacy of Flight Controls

5.55 At the recommended airspeeds, the windmilling engine provides adequate hydraulic pressure for the normal flight control system. During the landing rollout, lateral control is retained down to approximately 40 KIAS. With full elevator deflection (not normally required) or manual speedbrake extension at touchdown, normal flight controls become very stiff at approximately 80 KIAS. The manual flight control system must be selected in the event of engine seizure and provides adequate control, but the rapid control response required for high crosswind landing is lost.

Canopy / Windshield Frosting

5.56 Depending on atmospheric conditions and the altitude at which flameout occurs, some frosting of canopy and windshield can be expected. The majority of frosting will occur on the canopy, with some accumulation on the windshield side panels. The centre windshield panel is electrically heated by the emergency generator when the landing gear is retracted and will remain clear during the flameout glide.

Glide Performance

5.57 Rate of descent data with a seized engine is listed below for an aircraft fitted with 5 pylons, guns, and two

300-gallon external fuel tanks; and configured with gear down, speedbrakes closed, and flaps up. The data is based on an aircraft weight of 14,000 pounds and a speed of 180 KIAS. The correction factor for each 1000 pound difference is 5 KIAS and 100 FPM.

Table 5-1 Rate Of Descent – Flameout

Pressure Altitude (Feet)	Rate of Descent (FPM)
20,000	4,850
15,000	4,470
10,000	4,160
5,000	3,870
0	3,610

LOW PRECAUTIONARY APPROACH (LPA)

5.58 The LPA is depicted in Figure 5-5. It may be used whenever circumstances make it desirable; such as loss of oil pressure or other engine malfunctions which make it undesirable to reduce RPM. The variations in pattern entry and altitude allow a wide margin of flexibility. An 8000 foot runway is the minimum recommended. Select a field with crash equipment and arrestor gear, if practicable.

Entry

5.59 Entry to the LPA is dependent on the state of the emergency and weather conditions. The aim is to establish the aircraft on an extended glide path based on 1000 feet AGL for every 1 1/2 miles short of the runway threshold. The aircraft should be configured with the landing gear down by 1 1/2 miles from touchdown. Use flap and speedbrake as required to control the speed above 180 KIAS minimum. The rate of descent will be approximately 1900 to 2100 fpm.

AL 7(0)

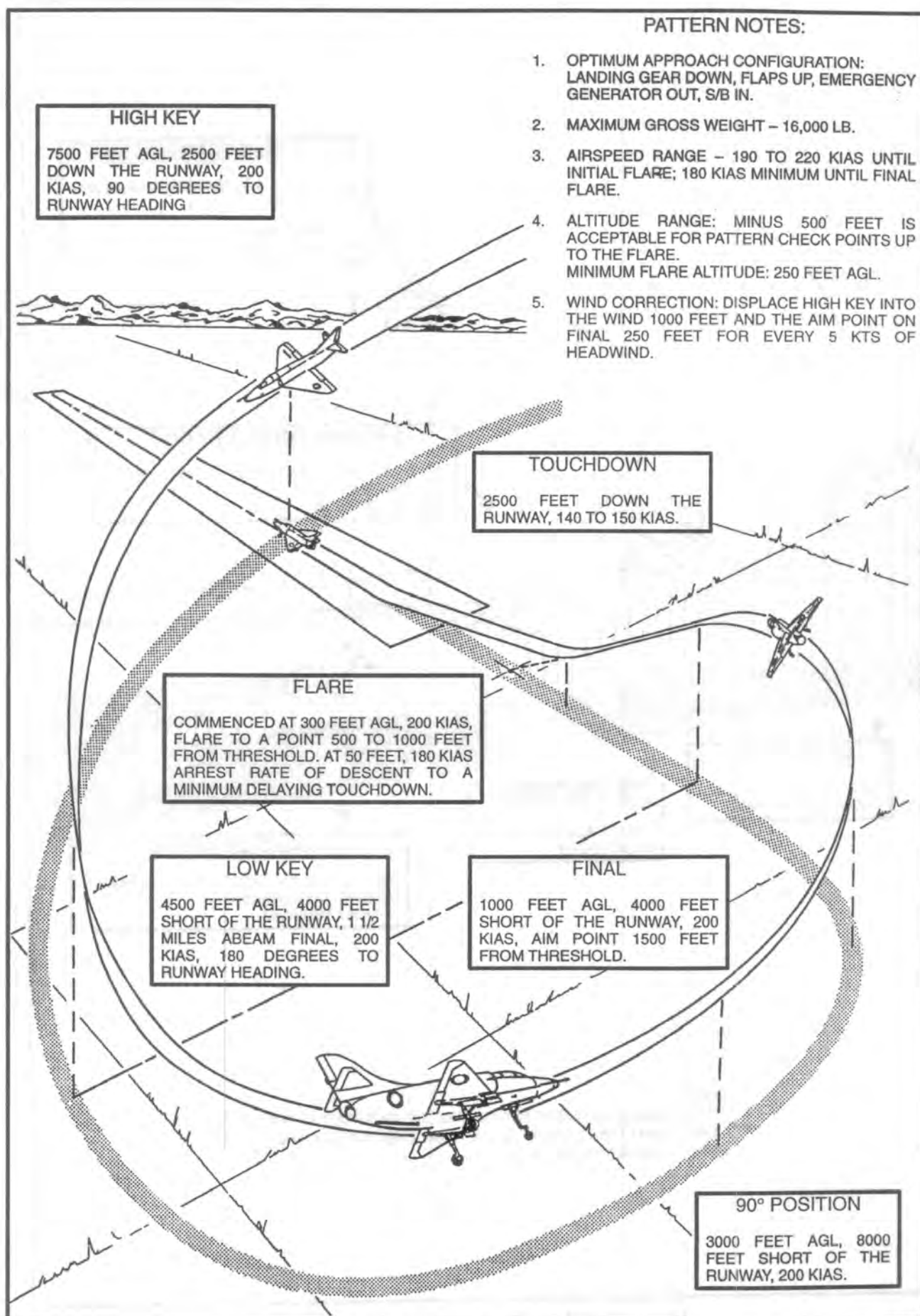


Figure 5-4 High Precautionary Approach

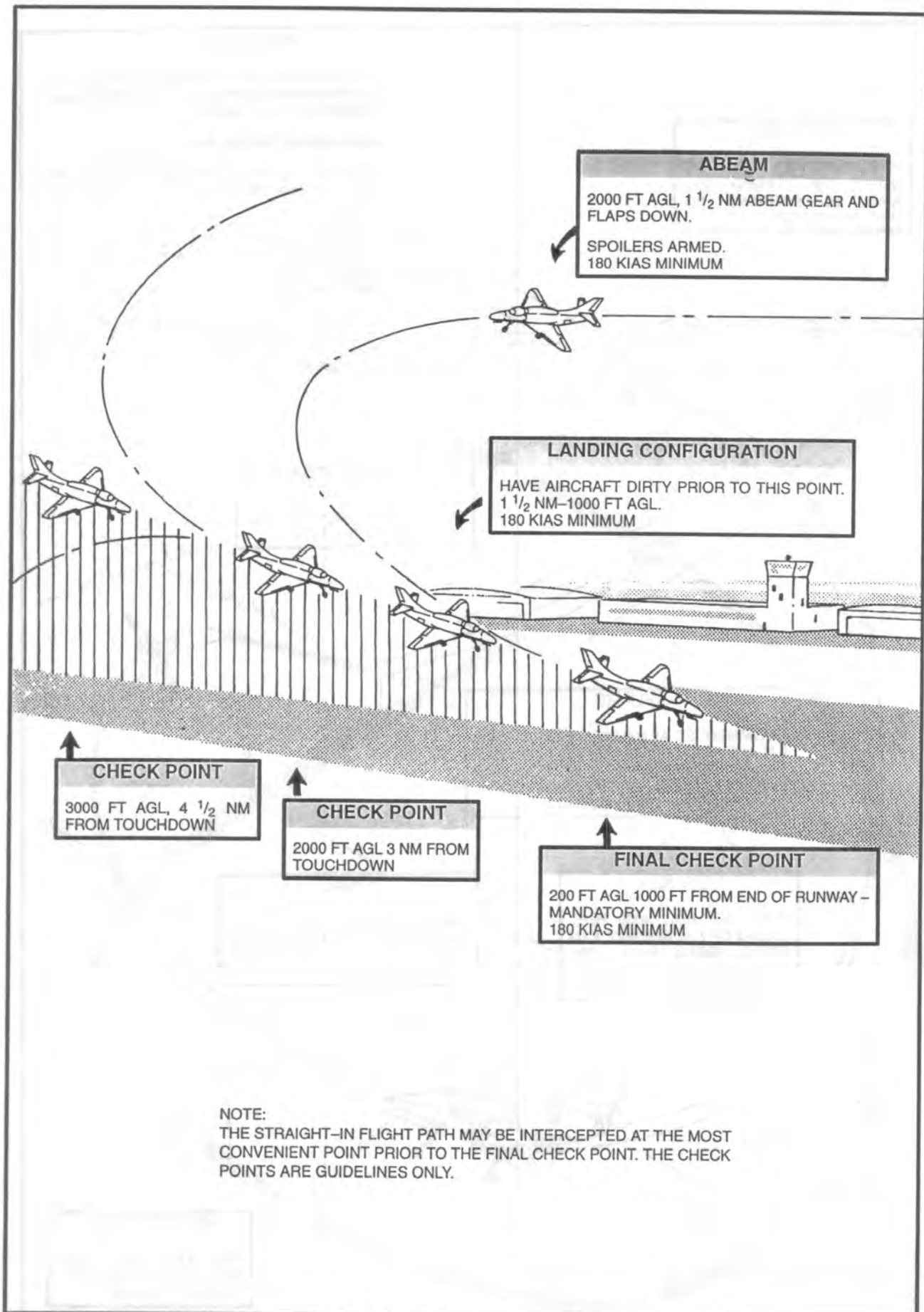


Figure 5-5 Low Precautionary Approach

AL 8(7)

Final Approach And Landing

5.60 An ejection attempt at low altitude in this approach leaves little margin for error. If ejection is decided upon, reduce the descent rate as much as possible and attempt to eject while wings are level. The final check point occurs at 200 feet AGL, 1000 feet short of the runway. This is the first point in the LPA from which a safe landing can be made if the engine fails. At this point reduce the power to idle. The glide slope should be maintained by raising the nose attitude, resulting in a decelerating approach. At 20 to 40 feet AGL, 170 KIAS, a flare is gradually commenced to hold the aircraft off the runway delaying touchdown until 140 KIAS and approximately 1500 feet down the runway. A minimum airspeed of 160 KIAS should be maintained until the flare is commenced.

Modified Low Precautionary Approach

5.61 An LPA can be flown to any emergency divert airfield if LASAPOSS action is required. An emergency divert airfield with a minimum length of 4,000 feet will allow a A-4/TA-4 weighing up to 16,000 lbs to land with a chute and no arrestor gear available.

NOTE

Although landing can be conducted at 16,000 lbs it is prudent to dump fuel to the minimum required to achieve the lightest landing weight possible.

5.62 The normal LPA pattern should be flown with an amended final check point at 200 feet AGL, 2,000 feet short of the runway. The new final check point corresponds with a six degree glide path with the flight path marker aiming 1,000 feet short of the threshold. At the final check point, reduce the power to idle and commence a flare. The touchdown point should be set 500 feet in from the threshold by raising the nose attitude, resulting in a decelerating approach. The flare is continued to touchdown at 140 KIAS and approximately 500 feet down the runway. The flare can be modified to trade off a closer touchdown point with landing at a higher airspeed, enabling the drag chute to be deployed as early as possible. The flare should also be modified for terrain or obstacles situated in front of the threshold.

STUCK THROTTLE APPROACH (STA)

5.63 The STA (Figure 5-6) should be used whenever it is impossible to change engine RPM. The aircraft needs to be

configured using a combination of gear, flaps, and speedbrakes to reduce the approach airspeed as much as possible to the minimum airspeed of 180 KIAS. The approach is flown on a 3 1/2 degree glideslope and the engine is secured at a predetermined altitude using the emergency fuel shutoff lever, enabling a safe landing from a decelerating approach. An 8000 ft runway with arrestor gear is the minimum recommended.

Entry Procedures

5.64 The primary concern, once it has been determined that a stuck throttle condition exists, is whether or not there is sufficient power available to maintain level flight. At intermediate thrust levels sufficient power for level flight may be marginal. With a stuck throttle condition near these RPM ranges, the aircraft should be flown toward the nearest suitable airfield for possible entry into the STA pattern. At about 10,000 feet AGL perform a transition to 180 KIAS, gear and flaps up and speed brakes in, to determine whether or not there is sufficient power for level flight. If, at 180 KIAS, steady state level flight cannot be maintained, there may be insufficient power to fly the STA and a decision must be made whether to enter the LPA pattern or eject. The LPA pattern can be successfully flown using only speedbrakes and angle of bank variations to compensate for engine thrust. If level flight or a rate of climb is maintained at 180 KIAS, sufficient power is available for safe execution of the STA and a controlled descent should be made toward the STA initial point.

Initial Point

(Power Available for Level Flight)

5.65 The initial point is a position approximately 3 NM, 500 feet AGL on the extended centreline of the runway. The aircraft should be flown to arrive at the initial point with the configuration as required to maintain at least a minimum approach airspeed of 180 KIAS. The flaps should be considered only as a drag device. At high thrust levels, even with gear and flaps down, speed brakes extended, airspeeds up to and exceeding 225 KIAS can be expected. With the engine RPM stuck in the lower acceptable STA RPM ranges a clean configuration will be required (gear and flaps up, speed brakes in) in order to maintain a minimum pattern airspeed of 180 KIAS. Once the approach configuration and a corresponding steady state airspeed has been determined, this airspeed should be maintained until engine shutdown by manipulation of the speed brakes. Engine shutdown will be accomplished through the use of the emergency fuel shutoff lever. In order that there is no delay at engine shutdown, the guard on the emergency fuel shutoff lever should be raised at the initial point and rechecked clear prior to glide slope interception.

AL 8(7)

Glide Slope Interception

5.66 500 feet AGL is maintained until intercepting the 3 1/2 degree glide slope, whereupon a pushover is made to commence descent, and the landing gear is lowered (if held because of minimum power considerations). If conditions dictate, an overshoot can be commenced any time prior to engine shutdown. At lower thrust levels, overshoot capability may be marginal or non-existent if the landing gear is not retracted or the airspeed is allowed to decrease below 180 KIAS.

Engine Shutdown, Final Approach And Landing

5.67 The engine shutdown point on the 3 1/2 degree glide slope corresponds to 150 feet AGL at an approach airspeed of 180 KIAS. The shut down altitude may be adjusted for other speeds by adding 25 feet to the altitude for every 10 KIAS above the base 180 KIAS. i.e., for an approach airspeed of 200 KIAS – shutdown at 200 feet AGL, for 220 KIAS – 250 feet AGL, etc. The radar altimeter is recommended because of accuracy considerations however the standard barometric altimeter is acceptable.

CAUTION

Every effort should be made to ensure that the emergency fuel shutoff lever is actually in the off detent. If it is not, the engine may not shut down or shutdown times may increase considerably and possibly prevent a safe landing.

5.68 At shutdown the engine will continue to run at the same thrust level for one (high power) to three (minimum power) seconds prior to thrust decay. The speedbrakes should be extended if not already out at this time. The glide slope should be maintained by raising the nose attitude, resulting in a decelerating approach. At 20 to 40 feet AGL, 170 KIAS, a flare is gradually commenced to hold the aircraft off the runway delaying touchdown until 140 KIAS and approximately 1500 feet down the runway. A minimum airspeed of 160 KIAS should be maintained until the flare is commenced. At touchdown utilize proper braking technique with consideration given to a possible long field arrest.

NOTE

Engine RPM usually deteriorates at a rate which results in the generator dropping off line approximately at touchdown. The use of the emergency generator just prior to touchdown will ensure that the drag chute can still be deployed after the main generator drops off line. However, actuation of speed brakes by emergency means will be required after the emergency generator is deployed.

Initial Point**(Insufficient Power for Level Flight)**

5.69 If insufficient power for level flight exists with a stuck throttle condition, an attempt can be made to land the aircraft safely by entering the LPA pattern. The LPA pattern can also be successfully flown using only speed brakes and angle of bank variations to compensate for engine thrust. The engine should be shut down using the emergency fuel shutoff lever when a runway landing is assured, but prior to the flare if possible.

ADDITIONAL CONSIDERATIONS**Wind Effect**

5.70 To correct for head wind, reduce shutdown altitude by 25 feet for every 10 Kts of head wind. A STA should not be attempted when the crosswind component exceeds 15 Kts because of the lack of spoilers. Normal hydraulic flight control is adequate down to approximately 40 KIAS. The use of manual flight control is not recommended.

High Power Approaches

5.71 For high power stuck throttle conditions use speedbrakes, G loading and/or a climbing attitude to reduce airspeed below 225 KIAS in order to lower the landing gear and flaps. Angle of bank can then be used in a spiralling descent, maintaining the airspeed below 225 KIAS, to arrive in the vicinity of the initial point. However, approach airspeeds up to 240 KIAS can be expected at high thrust levels.

Optimum Fuel Control Mode

5.72 There is an advantage in switching fuel control mode from primary to manual at both high and low thrust levels. For high power stuck throttle conditions a significant reduction in thrust can be realized. At low power a slight increase in thrust is likely, and at intermediate levels the effect can be either a rise or loss of thrust.

AL 7(0)

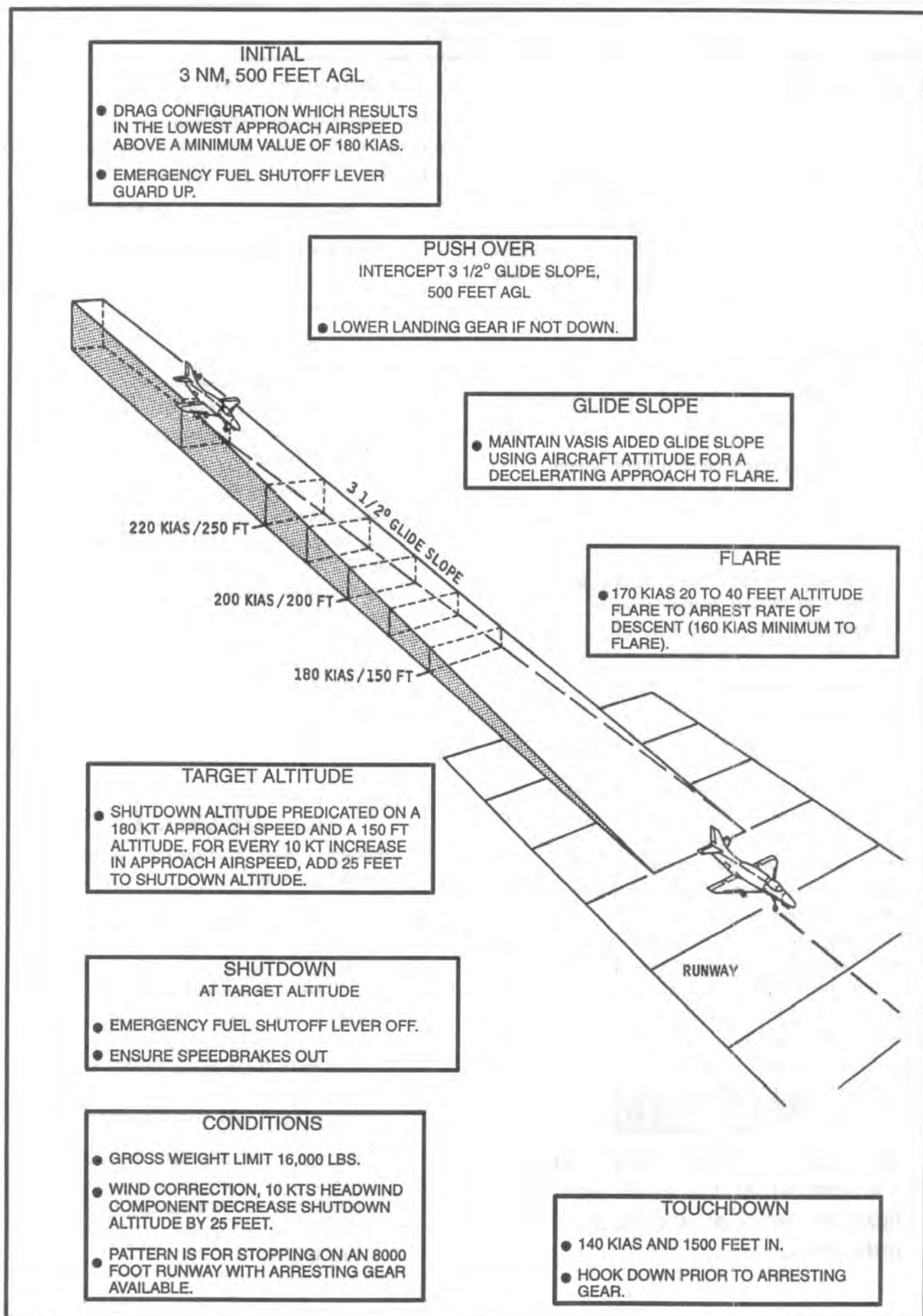


Figure 5-6 Stuck Throttle Approach (Sufficient Power for Level Flight)

FIRE

ENGINE FIRE

5.73 Illumination of the FIRE warning light is usually the first indication of a fire or an overheat condition in the engine compartment or tail section. The pilot should be alert for corroborating evidence that a fire actually exists before executing any drastic emergency procedure based on illumination of the fire warning light, as it is possible to have a false warning light in flight.

Secondary Indications of Fire

5.74 An actual fire will almost always be accompanied by one or more of the following:

Scorched or pungent odour in LOX system.

Emission of smoke or flames from tailpipe or other area.

Flickering or steady ladder lights, stiffening in elevator or aileron control pressures, partial or complete loss of one or more flight controls, or abnormal flap indications.

Explosion or unusual vibration.

Rising EGT and decreasing RPM, or excessive EGT.

5.75 One or more of the indications in paragraph 5.74 may be used to confirm a fire warning light indication that a fire exists. Grinding engine noises accompanied by abnormal oil pressure and illumination of the low oil (20 percent) indicator light may indicate the presence of an engine fire. If these or any other secondary indications are encountered, confirmation of fire indication should be made whenever possible through visual sighting by the pilot, a wingman, or other personnel. If no one is available to make this check, the pilot should bank the aircraft and observe the aircraft flight path for smoke.

WARNING

An engine fire may exist without illumination of the FIRE warning light or any of the secondary indications.

| Fire Warning Light / Fire In Flight

5.76 If the FIRE warning light comes on, the pilot should perform one of the following procedures, depending on the presence or absence of other indications of fire.

1.* **Throttle MIN FOR FLIGHT**

2.* **If fire confirmed EJECT or DELAY**

Follow procedure for delayed ejection with engine fire.

NOTE

1. Fire can be confirmed by either fire warning light and secondary indications, or confirmed visually.

2. Depending on the sequence of events and indications, immediate ejection may be initiated. However, the pilot must decide when to eject, taking into consideration aircraft altitude, attitude, airspeed, and condition, weather, chances for improving rescue/survival environment by gliding toward land or a ship, and other factors. (Refer to ejection.)

3.* **Fire not confirmed . . LASAPOSS USING MIN. POWER**

NOTE

Attempt visual confirmation of fire whenever possible.

4. **Master press-to-test DEPRESS**

NOTE

Failure of the FIRE warning light to function properly during press-to-test after signs of an in-flight engine fire has been encountered is cause for extreme diligence in monitoring for other indications of fire.

5. If at any time during flight, the FIRE warning light is illuminated, or secondary indications are present with no FIRE warning light, or engine fire is suspected, monitor aircraft for fire and LASAPOSS.

AL 8(7)

5.77 If there is no other indication of fire, it is most likely that false FIRE warning light indication exists. Land as soon as possible at nearest landing facility. If there is any evidence that fire actually exists after touchdown shutdown engine immediately. Move manual fuel shut off control lever to EMERG OFF. Abandon aircraft as soon as the aircraft comes to a stop.

Delayed Ejection with Engine Fire

5.78 If secondary indications exist, but the decision is made to delay ejection, accomplish the following:

- 1.* Throttle OFF
- 2.* Manual Fuel Shut-off EMER OFF
- 3.* RAT DEPLOY
- 4.* External Stores JETTISON

WARNING

If the fire is successfully extinguished by selecting the Manual Fuel Shut-off to EMER OFF, DO NOT attempt an engine restart as this may result in an explosion or re-ignition of the fire.

NOTE

Extinguishing of an engine fire is evidenced by disappearance of FIRE warning light and other indications of fire.

- 5.* If fire continues EJECT

Bleed Air Ducting Failure

5.79 Bleed air is obtained from the 7th stage of the N2 high pressure compressor unit. This air is extremely hot and if a leak develops in the ducting system, the air may ignite or cause severe heat damage to materials adjacent to the leak. Cockpit indications of duct failure are very similar to those of the inflight engine fire. Determination of whether the problem is one caused by the engine or by ducting failure is difficult. A fire warning light caused by bleed air leakage can usually be eliminated by a reduction in power which will reduce the flow of bleed air. Every indication must be weighed in evaluating the cause, including external observation by a wingman. Immediate evaluation is of the utmost importance.

5.80 If it is determined that bleed air is the source of trouble:

- Use minimum power consistent with safe flight.
- Continue checking for indications of fire.

Land as soon as possible.

WING FIRE IN FLIGHT

5.81 A fire in the wing could be caused by either fuel leakage or defective electrical wiring. Proceed as follows:

- 1.* Combustible Stores JETTISON
- 2.* RAT DEPLOY
- 3.* If fire persists EJECT
4. If fire is electrical in nature, follow procedure for electrical fire.

ELECTRICAL FIRE

5.82 When a fire seems to be electrical in origin, proceed as follows:

- 1.* RAT DEPLOY
- 2.* If fire persists ALL ELECTRICAL EQUIPMENT OFF
3. If fire is extinguished, turn ON only necessary equipment, one at a time. If offending circuit is again energised, secure it.
4. If fire cannot be extinguished in this manner, pilot must decide whether to land as soon as possible or eject.
5. If landing is made, use short field arrestor gear if available. shutdown engine upon coming to a stop.
6. Refer to page 5-48 for recommended SHORT FEILD ARREST procedures.

CAUTION

During the landing roll the emergency generator goes off line, allowing the operating main generator to again take the load. An electrical fire previously extinguished by deploying the emergency generator may reignite unless the engine is shut down.

SMOKE OR FUMES

5.83 There are several sources of fog, smoke or irritating fumes in the cockpit. These sources are as follows:

Air conditioning system.

Bleed-air line may not be connected to g-suit valve, or there may be improper assembly of valve.

Torn canopy seal.

Electrical fire in cockpit.

Birdstrike where the bird has been ingested by the engine.

AL 8(7)

Elimination of Smoke or Fumes

5.84 If smoke or fumes are detected in the cockpit, proceed as follows:

- 1.* **Oxygen Regulator 100% / EMERGENCY**
- 2.* **Mask TOGGLE DOWN**
- 3.* **Temperature control MANUAL HOT**

NOTE

High ambient moisture conditions combined with low cockpit temperature selections may result in fog being produced by the air conditioning system.

The temperature controller may need to be held in MANUAL HOT for up to 8 seconds to move the valve in the fully open position.

- 4.* **Cabin Pressurization RAM**

NOTE

Selection of RAM on the cockpit pressure switch will correct only the smoke or fumes from the air conditioning system.

5. If smoke or fumes are not eliminated, lift

oxygen mask for a cautious smell. Do not inhale deeply due to the possible presence of oil fumes that are highly toxic.

6. If odour smells like burning or hot electrical insulation, proceed as in Electrical Fire
7. If it is determined that the smoke or fumes are not electrical in origin, be alert for other evidence of fire.
8. If smoke or fumes cannot be eliminated and so limit vision that safe landing could not be made, or if are accompanied by excessive cockpit temperatures, slow aircraft and jettison canopy.

WARNING

Slow aircraft as much as possible prior to jettisoning canopy. With the canopy removed from the aircraft the rear seat occupant of the TA-4 is susceptible to inadvertent ejection.

9. LASAPOSS.

AL 8(7)

SYSTEMS FAILURES

HYDRAULIC SYSTEMS FAILURE

WARNING

If a hydraulic system is lost in flight, be alert for evidence of fire. As the possibility exists of an engine section fire, the engine should be shutdown immediately after landing.

Flight Control Hydraulic System Failure

5.85 Illumination of either the UTILITY HYD or CONTROL HYD warning lights indicates a loss of hydraulic pressure to one side of the tandem flight control units. No means are available to the pilot to restore hydraulic system pressure.

1. Avoid manoeuvres requiring high control forces.

CAUTION

The manual flight control handle must not be pulled unless both the Flight Control and the Utility systems have failed.

2. LASAPRAC, preferably via a short field arrest due to the fire hazard of a hydraulic leak.
3. Refer to Page 5-48 for recommended procedures prior to Short Field Arrest.

5.86 When operating on utility system alone, actuation of various units operated by utility system pressure, will cause a temporary decrease in the effectiveness of the flight controls.

Utility Hydraulic System Failure

5.87 In the event of illumination of the UTILITY HYD warning light, proceed as follows:

1. * Flap Lever STOP
2. * Nosewheel steering EMER OFF
3. Avoid manoeuvres requiring high control forces.

WARNING

Do not attempt further selection of flap due to the risk of fire.

CAUTION

Flap, AFCS, speedbrake, spoilers, hook (UP), nosewheel steering and normal canopy opening (TA-4) will be inoperative.

4. LASAPRAC using flapless approach, preferably via a short field arrest due to the fire hazard of hydraulic failure.

NOTE

If an arrested landing is not available, an increased landing roll of approximately 100% can be expected in a no flap, no speedbrake, no spoiler configuration.

5. Refer to Page 5-48 for recommended procedures prior to Short Field Arrest.
6. Refer to Page 5-44 for Emergency Gear Extension Procedure.

Complete Hydraulics Failure

5.88 Illumination of both UTILITY HYD and CONTROL HYD warning lights and a stiffening of the controls indicates a complete hydraulic failure. The following procedure should be followed for flight control disconnect:

1. Terminate any accelerated manoeuvre.
2. Reduce airspeed to 200 KIAS, if possible. (Asymmetric Load – MAX 200 KIAS).
3. Flap Lever STOP
4. Nosewheel Steering EMERG OFF
5. Trim aircraft laterally.

NOTE

As long as (normal) electrical power is available, the ailerons and horizontal stabilizer can be trimmed.

6. Manual flight control handle PULL
7. Retrim immediately, if required.
8. Avoid manoeuvres requiring high control forces.

WARNING

Do not attempt further selection of flap due to the risk of fire.

CAUTION

Flap, AFCS, speedbrake, spoilers, hook (UP), nosewheel steering and normal canopy opening (TA-4) will be inoperative. If carrying asymmetric load, avoid excessive longitudinal stick motion or consider stores jettison.

9. LASAPRAC using flapless approach, preferably via a Short Field Arrest.

CAUTION

If crosswind exceeds 8 Kts, make short field arrest. If an arrested landing is not available, an increased landing roll of approximately 100% can be expected in a no flap, no speedbrake, no spoiler configuration.

10. Refer to Page 5-48 for recommended procedures prior to short field arrest.
11. Refer to Page 5-44 for Emergency Gear Extension Procedure.

Utility / Complete Hydraulics Failure: Landing

5.89 Select landing gear down. If the landing gear does not lower, emergency extension of the landing gear and a no flaps approach and landing will be required. Spoilers and nosewheel steering will be inoperative. Landing gear safety pins should be installed as soon as possible after landing. Because arrestor hook extension and the wheel brakes systems are completely independent of the aircraft's hydraulic system both will still be available. However, since the arrestor hook cannot be retracted without hydraulic pressure, it should not be extended in flight until a short field arrest is planned.

NOTE

If an arrested landing is not available, an increased landing roll of approximately 100 percent can be expected in a no flap, no speedbrake, no spoiler configuration.

MANUAL FLIGHT CONTROL

Performing Manual Disconnect

5.90 The manual flight control handle should be pulled fully out (about 1 foot) with a rapid and positive motion. This action will assure a clean disconnect and will aid in preventing a tendency for the aircraft to roll as the switch to manual control is made. The manual flight control mechanism cannot be reset in flight once it has been disconnected. If for any reason, the manual flight control handle is pulled while hydraulic pressure is still available, a metallic thud will be heard when the stick is moved. This sound, caused when hydraulic pressure slams the piston against the end of the cylinder, is normal for the system under the above conditions, and should not be a cause for alarm.

NOTE

In case of excessive nose pitch down, the use of speedbrakes may cause increased nose down tendency due to the design of the speed brake system.

When a disconnect has been made and utility hydraulic system pressure is available, it is possible to engage and utilize the AFCS to reduce stick forces. The spoilers may also be used for landing. The tandem rudder actuator is not disconnected by the flight control disconnect handle and high rudder forces can be expected.

Landing: Manual Flight Control

5.91 With the hydraulic power disconnected from the flight controls and all other systems operative, a modified straight in approach should be utilized. If the utility hydraulic system is inoperative, modify the approach as specified for landing with no flaps or speed brakes. Maximum recommended crosswind component for landing is 8 knots. Above 8 knots, an arrested landing is recommended.

Landing: Asymmetric Loading

5.92 Hydraulic power disconnects should not be performed with asymmetric loadings. If a hydraulic power disconnect must be made with asymmetric loadings, the following is recommended:

1. Speed prior to disconnect : . 200 KIAS MAX
2. After disconnect, avoid excessive longitudinal stick motion.
3. Plan the approach to ensure that cross wind is under the heavy wing if possible.

AL 8(7)

4. Recommended approach airspeed is 140 KIAS with minimum final approach and touchdown airspeed of 125 KIAS. Minimum recommended lateral control speed is 115 KIAS (7500 ft/lbs asymmetric load) up to 130 KIAS (12500 ft/lbs asymmetric load).

ELECTRICAL SYSTEMS FAILURE

Main Generator Failure

5.93 Partial or complete failure of the main generator to provide the required power output may be caused by CFG failure, blown fuse(s), and other mechanical or electrical discrepancies. Partial failure may result in loss of one or more phases of AC, or reduced or fluctuating frequency or voltage, and may be impossible to detect from cockpit indications. The most likely signs of a partial failure will be TACAN unlocking and spinning, loss of air conditioning, erroneous attitude presentation on the ADI with or without an OFF warning flag indication, or abnormally slow trim motor speed.

5.94 TACAN breaking lock-on, variation of instrument light intensity, sluggish or unstable gyro action, and variations in UHF background noise when associated with throttle reductions are an indication of impending generator drive transmission failure. Under this condition, continued throttle manipulation can induce various fuse failures including DC converter fuse failure. It is recommended that throttle manipulation be reduced to a minimum. If symptoms persist, deploying the emergency generator will prevent loss of power as long as airspeed is kept at or above 145 KIAS.

CAUTION

In the event of a Main Generator malfunction, or failure, avoid cycling the generator NORMAL/BYPASS switch below 145 KIAS. Below 140 KIAS the power output from the emergency generator may be insufficient to close the emergency generator transfer relay, thus in the event of total Main Generator failure, all electrical power will be lost even though NORMAL/BYPASS switch has been returned to NORMAL.

5.95 If the main generator should fail completely, all electrical equipment will be rendered inoperative immediately. The most easily recognisable indications of complete main generator failure occur simultaneously, as follows:

- Immediate loss of HUD, DUs, ladder lights.
- Landing gear indication unsafe.

Flap position indications off scale.

Trim position indicator off scale.

Radios, TACAN, and lights inoperative.

5.96 When a main generator failure is known or suspected, proceed as follows:

1. If IMC, refer to head down instruments.

- 2.* RAT DEPLOY

WARNING

Aircrew should use extreme caution when deploying the Emergency Generator to avoid any contact with the Canopy Jettison Handle. A palm-down method of grasping the Emergency Generator Handle is recommended.

CAUTION

To prevent damage to the RAT, do not deploy at airspeeds above 500 KIAS/0.91 IMN (A-4); 450 KIAS/0.82 IMN (TA-4).

NOTE

INU shuts down after 10 secs unless the RAT is deployed.

Maintain 145 KIAS for HORI STAB operation.

FUEL BOOST and DC-2 inoperative.

Above 25,000 ft throttle 90% or less.

RAT bypass switch in NORMAL.

Applying positive G may dislodge the emergency generator if it fails to deploy when the handle is pulled.

After deployment of the emergency generator, land as soon as practicable as lengthy operation of this unit can seriously deteriorate its performance.

CAUTION

Use of the Horizontal Stabilizer override trim below 140 KIAS could result in all available power from the Emergency Generator being transferred via the Horizontal Stabilizer Emergency Power Priority Switch, thus dropping all other electrical services powered from the Emergency Generator "off line".

AL 8(7)

NOTE

At low indicated airspeeds, the Emergency Generator may not be capable of supplying adequate electrical power to support the equipment powered from the Forward Primary AC Bus.

Prolonged operation of the horizontal stabilizer whilst at low IAS and utilising RAT power could adversely affect the ability of the INU battery to support continued operation of the INU.

- 3. TACAN MANUALLY TUNE APPROPRIATE FREQUENCY
 - 4. NAS ... SELECT NAVAID REF IF REQD
 - 5. ARC-159 TUNE APPROPRIATE FREQUENCY
- 5.97 If total loss of electrical power is due to CFG failure, there is a possibility that the generator may reset once the Emergency Generator has been deployed.
- After 2 minutes on RAT, attempt CFG reset:
- 6. NORMAL/BYPASS Switch **BYPASS**
If CFG has reset, normal electrical services will be restored. If services are not restored:
 - 7. NORMAL/BYPASS Switch **NORMAL**

NOTE

If still airborne after a further 10 minutes on RAT, repeat above procedure. If unsuccessful, DO NOT ATTEMPT FURTHER RESETS.

- 8. LASAPRAC.
- 9. Advise tower that radio communication will be lost during landing rollout and that the drag chute may need to be draped over the arrestor hook before taxiing.

- 10. Prior to landing, and
loss of RAT power. NAS OFF

NOTE

Regardless of whether the CFG has reset, the aircraft should still be landed as soon as practicable due to the possibility of lengthy operation seriously deteriorating the performance of the Emergency Generator.

Table 5-2 Services Available On the RAT

26 VAC Utility and Instrument Bus	
INU	Hose jettison
ADF	Oil pressure
Emergency Bomb Jettison	
28 VDC Primary Bus	
TACAN	Master caution
ARC-159	Ignition timer
IFF	Trim position
Wheels/Flap position indicators	DC test
Fuel quantity (Wing/Ext)	Cabin pressure (Normal/Ram)
FIRE warning	Audio isolation amp
Retraction release switch	Drag chute
NAS control transfer (TA-4)	
Forward Primary AC Bus	
Engine control	*Windshield heat (Centre)
Oil quantity switch	Fuel Dump
Horizontal stabiliser trim	Warning lights relays
HSI	Instrument lights
Igniters	Red floodlights
AoA indexers	Air conditioning
*AoA heat	Fuel flow
28 VDC Master and Primary ARM Buses	
Manual guns (left hand gun only)	
* Inoperative with gear handle down.	

AL 8(7)

Main Generator Failure: Services Affected

5.98 When operating on the emergency generator the following buses are lost as shown in Foldout 4:

FWD and AFT Monitored AC buses.

FWD and AFT Monitored DC buses.

Monitored ARM bus.

5.99 The services still available on the emergency generator are listed in Table 5-2. In addition, the Forward Primary Monitored AC bus is lost whenever the Horizontal Stabilizer Emergency Override is operated.

5.100 The services inoperative on the emergency generator are listed in Table 5-3.

5.101 Table 5-4 lists the services that are inoperative on the emergency generator when the Horizontal Stabilizer Emergency Override is operated.

Table 5-3 Services Inoperative On The RAT

HUD/UFC	Barometric Altimeter Vibrator
DUs	Fuel Booster Pump
VOR/ILS	EPR Gauge
ARC-182	Chaff/Flare dispenser
Spoilers	Rain removal
TACAN will require manual tuning	Seat actuator
All normal trim	All external lights
Radar altimeter	White floodlights
Nosewheel steering	LAWS
AFCS	RWS
Radar	Minipan Camera
AVTR	Salt Removal
DTMR	Normal speedbrake operation
All weapons delivery (except manual guns and emergency jettison)	
Normal droptank transfer (fuel transfers automatically)	
CIU	HSI: CDI bars To/From indications Course commands
	ADI: Steer Pointers
	DME Hold
	Paired Tuning
	Offset Nav

Table 5-4 Services Inoperative When Horizontal Stab Operated

FORWARD PRI MON AC BUS	
Low Fuel Warning	FIRE Warning
Pitot Heat	Engine Anti-ice
Fuselage Fuel Quantity	ADF
LOX Quantity	Altimeter Encoder
Rate Gyro (Turn needle)	ADI (3 mins without power)

5.102 When operating on Emergency Generator and the Horizontal Stabilizer Emergency Override is operated, electrical power will be removed from the following:

NOTE

The ADI and Turn Needle will continue to provide correct information for 3 minutes with no power applied.

Emergency generator power to operate the angle-of-attack vane heater and the nesa glass heater will not be available when the landing gear is down. Power may be restored by first retracting the landing gear and then cycling the Emergency Generator BYPASS switch.

DC-1 Converter Failure

5.103 Failure of the Number 1 DC Converter will be indicated by the illumination of the DC-1 caution light.

5.104 All electrical power carried by the Number 1 DC Converter will be automatically transferred to the Number 2 DC Converter with no affect on system operations.

1. Gain and maintain VMC.
2. Terminate mission and RTB.

DC-2 Converter Failure

5.105 Failure of the Number 2 DC Converter will be indicated by the following:

Immediate loss of HUD, DUs, ARC-182.

DC 2 and Master Caution Lights illuminated.

1. If IMC, refer to heads down instruments.
2. Master Caution CANCEL
3. NAS SELECT NAVAID REF
IF REQD
4. TACAN MANUALLY TUNE
APPROPRIATE FREQUENCY
5. ARC-159 TUNE APPROPRIATE
FREQUENCY
6. Gain and maintain VMC.

AL 8(7)

NOTE

No spoilers, stick trim, NWS or speedbrakes (manual operation only). Drag chute is available.

7. LASAPRAC.

5.106 Refer to Table 5-5 for services inoperative with DC-2 failure.

Table 5-5 Services Inoperative With DC-2 Failure

HUD/UFC	AFCS
DUs	Baro alt vibrator
VOR/ILS	Salt removal
ARC-182	AVTR
Spoilers	Chaff/Flare dispenser
TACAN will require manual tuning	LAWS
All normal trim	Radar
Nosewheel steering	Minipan camera
Normal speedbrake operation	
All weapons delivery (only manual guns available)	
CIU	HSI: CDI bars To/From indications Course commands
	ADI: Steer Pointers
	DME Hold
	Paired Tuning
	Offset nav
	RWS: No Bearing

NOTE

Although the INU is still operating, no NAS navigation information is available because both CIU and DP are inoperative.

TACAN information will be displayed on the HSI only.

Dual Converter Failure

5.107 Failure of both DC Converters will be indicated by:

Immediate loss of HUD, DUs, both radios.

Fuel indications drop to 1,600 lbs (A-4), 550 lbs (TA-4).

Illumination of LOW FUEL Warning Light.

DC 1/DC 2 Caution lights illuminated. No Master Caution.

5.108 Proceed as follows:

1. If IMC, refer to heads down instruments.

NOTE

Only the pressure instruments, ADI and standby compass are available.

- 2.* Gain VMC.

- 3.* LASAPRAC.

4. Arrested landing is recommended.

5. Refer to Page 5-48 for recommended procedures prior to Short Field Arrest.

CAUTION

Services inoperative; stick trim, spoilers, drag chute, nose wheel steering, and speedbrake (manual operation still available).

5.109 In addition to those services listed in Table 5-5 the services listed in Table 5-6 will be inoperative in the event of a dual converter failure.

Table 5-6 Additional Services Inoperative With A Dual Converter Failure

TACAN	ADF
ARC-159	Trim Position Gauge
INU: HSI fixed at 360°	Retraction Release Switch
Drag Chute	Audio Isolation Amplifier
IFF	Ignition Timer (No Relight)
Wheels/Flap Gauge	HYD Warning lights
MASTER CAUTION relay	RRS Caution light
Emergency Wing Fuel Transfer	DC Test circuit
FIRE Warning light	FUEL BOOST/TRANS lights
Oil quantity switch	OIL PRESS Warning light
NAS transfer switch (TA-4)	
Wing/Ext fuel sensors (fuel quantity indicates fuselage only)	
All armament circuits (except emergency jettison)	
Air Conditioning and Pressurization: cannot be turned off (TA-4) cannot open Relief valve cannot open Ram Air valve	
*LOW FUEL warning light will illuminate, however, it does not provide correct indication of low fuel state.	

AL 8(7)

Computer Interface Unit (CIU) Failure

5.110 A complete or partial failure of the CIU will result in various levels of degradation. If the failure is such that the HUD and UFC are still operating, the following annunciations may be displayed on the pilots fault list as shown in Table 5-11.

CIU ANALOG

CIU BATTERY

CIU FAIL

CIU MEMORY

CIU PROGRAM

5.111 A CIU failure will be indicated by the following:

No HUD.

BACKUP on DU STATUS page.

BIT light on UFC will not illuminate, however FAIL caption will be shown on DU. Cannot acknowledge.

5.112 In the event of a CIU failure, proceed as follows:

1. If IMC, refer to heads down instruments.
2. NAS Power Panel . . . Cycle CIU power switch in an attempt to reset CIU
If unsuccessful:
3. NAS Power Panel CIU OFF
4. LASAPRAC.

The DP will takeover many of the functions previously carried out by the CIU and will provide backup NAS navigation.

NOTE

Radios, TACAN, VOR and UHF ADF are still available.

5.113 The DP will assume many of the functions carried out by the CIU and will take over control of the data bus so that the other connected units and systems can continue to communicate. If the INU is in the NAV mode when the CIU fails, the DP will provide backup NAS navigation functions. No backup INU alignment capability exists. If the NAS mode is selected from the Nav Panel, point to point navigation will be possible using primarily the HSI bearing and distance indications. Manual selection of previously defined waypoints between 00 and 49 (excluding O points) will be provided through the DU. Drift and wind velocity will be displayed on the DU STATUS page by the DP.

5.114 ILS stations can be tuned but glideslope/localizer data cannot be displayed. TACAN and VOR/ILS must be individually tuned; TACAN via the TACAN control panel, and VOR/ILS via the DU. Bearing and range information will be displayed on the HSI.

5.115 All NAS auto weapons modes are unavailable. Use the MANUAL WPNS switch, station select switches and standby sight.

5.116 Table 5-7 lists the services inoperative in the event of a total CIU failure, or if power is removed to the CIU at the NAS Power Panel.

Table 5-7 Services Inoperative With CIU Failure

HUD/UFC (STBY reticule still available)	AVTR: Auto modes Event marking
ARC-182 & VOR/ILS: Cannot tune through UFC	HSI: To/From Indications Course Commands
TACAN: Must be manually tuned	ADI Steering Bars
RAD ALT	DTM
LAWS	DME Hold
Paired Tuning	RWS True bearing
Radar	Offset Nav
Auto Weapons	AGM-65 delivery
AFCS: NAS-coupled steering	AIM-9: Boresight only

Display Processor (DP) Failure

5.117 A complete or partial failure of the DP will be shown by one or more of the following fault list annunciations as shown in Table 5-11:

DP FAIL

DP SYMBOLS

DP BATTERY

5.118 The Display Processor controls all textual information displayed on the DU and all DU video switching. A complete failure of the DP will result in the loss of all head down data entry and confirmation, otherwise mission capability is unaffected. The DUs will default to show radar video on the left DU and AGM 65 video on the right. If AGM 65 is not carried, the right DU will be blank.

5.119 In the event of a DP fault annunciation, proceed as follows:

1. Acknowledge fault.
2. NAS Power Panel . . . Cycle DP power switch in an attempt to reset DP
If unsuccessful, and in Day VMC only:
3. NAS Power Panel . . . Cycle CIU power switch in an attempt to reset CIU

AL 8(7)

If unsuccessful:

4. NAS Power Panel DP OFF

NOTE

The Display Processor controls all textual information displayed on the DU and all DU video switching. A complete failure of the DP would result in the loss of all head down data entry and confirmation, otherwise mission capability is unaffected.

5.120 A DP fault annunciation may result in all or some of the services in Table 5-8 being inoperative. Selecting the DU OFF at the NAS power panel will certainly de-energize these services, but may prevent further damage to the DP.

Table 5-8 Services Inoperative With DP Failure

DU Select Facility: Select Manual Weapons Switch to AGM-65 to power up Maverick
VOR/ILS Marker Beacon Sensitivity (Default HI)
TACAN Mode Change (Default T/R if 00 on control panel)
ARC 182 Mode Control (Default Man/Preset, T/R+G, Squelch ON, UHF AM)
NAS Auto/Manual Sequencing (Default Manual)
AFCAS NAS Navigation Mode Changes
AVTR Video (audio still available)

Inertial Navigation Unit Failure

5.121 An INU failure is announced by one or both of the following fault list annunciations as shown in Table 5-11, together with an ATTITUDE fail annunciation:

INU FAILURE

INU NAVIGATION

5.122 The most obvious indications, apart from the fault list annunciations, are as follows:

INU Fail or ATTITUDE annunciation on HUD.

Loss of HUD Hdg, FPM, QVV, Steering, Dest box, G, VSI.

HSI compass card driven to 360 degrees.

5.123 In the event of an INU fail annunciation, proceed as follows:

1. If IMC, refer to heads down instruments.
2. Acknowledge fault.
3. NAS Power Panel INU OFF

4. LASAPRAC.

5. For IMC recovery, make No Compass GCA if available.

NOTE

Do not turn INU off at the NAS Panel as this will remove power to the CIU, DTMR, DP and DADC.

Backup attitude from the ADI will be presented on the HUD.

5.124 With an INU failure, or with power removed from the power panel, the following services are inoperative:

Table 5-9 Services Inoperative With INU Failure

HUD - all INU derived data	RWS True bearing
HSI - Compass driven to 360°	ADI - NAS Steering
NAS navigation	Auto Weapons delivery except AGM-65
Offset Nav	

5.125 An INU failure will seriously limit mission capability. It eliminates all NAS heading information, all self contained point to point navigation, and all aided weapon delivery modes. The following navigation data is still available after an INU failure:

TACAN or VOR radial information displayed against the HSI compass card which will be driven to a heading of 360° and fixed.

DME information

Standby compass

Relative ADF bearing

Digital Air Data Computer (DADC) Failure

5.126 A partial or complete failure of the DADC will be annunciated on the fault list by DADC FAIL. The failure will also be indicated by the loss of the following HUD data:

Loss of HUD Baro Alt, IAS, AoA, QVV, VSI.

DADC FAIL annunciation on HUD.

5.127 In the event of a DADC failure, proceed as follows:

1. If IMC, refer to heads down instruments.
2. Acknowledge fault.
3. NAS power panel Cycle DADC Power switch in an attempt to reset DADC

If unsuccessful, and in day VMC only:

4. NAS power panel Cycle CIU Power switch in an attempt to reset CIU

AL 8(7)

If unsuccessful:

5. NAS Power Panel DADC OFF
6. LASAPRAC.
7. During approach use AoA indexers/speed, as HUD AoA scale is lost.

CAUTION

One function of the DADC is to 'bound' the sensitive Z axis output of the INU. When the RAT is extended during training the DADC is inoperative and the INU Z axis output is unbounded. When BYPASS is selected on the generator, the FPM position may be inaccurate until the DADC can provide accurate bounding for approach.

NOTE

HUD pitch bars will be referenced to the ADL since the FPM is unavailable.

5.128 In addition to the above HUD data, Table 5-10 lists the services that will be affected by a DADC failure.

Table 5-10 Services Inoperative With DADC Failure

HUD pitch bars will be referenced to ADL Bomb Fall Line referenced to ADL. Weapons delivery degraded to no wind solution. A/A missile mode: Boresight launch only. No envelope prediction or target velocity. AGM 65 mode – missile LOS boresighted at ADL. AFCS – Cannot engage (including Stab Aug).
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NAS FAILURE ANNUNCIATIONS

5.129 Table 5-11 shows the various HUD annunciations used to inform the pilot of a system or sub-system failure found during C-BIT or I-BIT routines.

Table 5-11 Fault Annunciations and Required Actions

HUD Annunciation	REQUIRED ACTION / Explanation
15 VDC FAIL	NONE The 15 VDC power supply has been detected as failing. Slewing on the HUD and the AGM-65 are lost. The CTVS is inoperative for HUD standby reticule operations.
AFCS ATTITUDE	DISCONTINUE AFCS OPERATIONS, EXCEPT FOR STAB AUG A minor failure has been detected in the AFCS that does not affect stability augmentation operation. All other modes are automatically disengaged.
AFCS STAB AUG	NONE A major AFCS failure has been detected. AFCS is no longer available, including stability augmentation.
AIM-9 LOAD ERR	VERIFY NAS WEAPON INVENTORY The NAS weapon inventory does not agree with the stations identifying an AIM-9 missile attached.
ARC 182 FAIL	OBSERVE ARC-182 FOR EVIDENCE OF IMPROPER OPERATION. USE ARC 159 IF NECESSARY A failure has been detected in the ARC-182 system.
ARMAMENT	TERMINATE WEAPONS DELIVERY. WEAPON RELEASE CAN OCCUR UNEXPECTEDLY A failure has been detected in the CIU armament armament release circuitry. If necessary, degrade to manual weapons.
AVTR FAIL	SELECT AVTR OFF A failure has been detected in the AVTR.
CIU ANALOG	OBSERVE NAS FOR EVIDENCE OF IMPROPER OPERATION. IF NAS IS INOPERATIVE, SELECT CIU POWER OFF. USE BACKUP NAVIGATION AND MANUAL WEAPON DELIVERY A CIU analog failure has been detected.
CIU BATTERY	ENTER TAIL NUMBER AND BORESIGHT CONSTANTS ON A/C DATA PAGE. LOAD DTM. IF DTM NOT AVAILABLE, MANY DTM LOADABLE DATA ITEMS MAY BE MISSING FROM CIU MEMORY The CIU battery used to retain data during power off periods has failed.
CIU FAIL	OBSERVE NAS FOR EVIDENCE OF IMPROPER OPERATION. IF NAS IS INOPERATIVE, SELECT CIU POWER OFF. USE BACKUP NAVIGATION AND MANUAL WEAPON DELIVERY A major failure has been detected in the CIU. Refer to paragraph 5.110 CIU FAILURE.
CIU MEMORY	OBSERVE NAS FOR EVIDENCE OF IMPROPER OPERATION. IF NAS IS INOPERATIVE, SELECT CIU POWER OFF. USE BACKUP NAVIGATION AND MANUAL WEAPON DELIVERY A random access memory (RAM) failure has been detected in the CIU.
CIU PROGRAM	OBSERVE NAS FOR EVIDENCE OF IMPROPER OPERATION. IF NAS IS INOPERATIVE, SELECT CIU POWER OFF. USE BACKUP NAVIGATION AND MANUAL WEAPON DELIVERY A program memory failure has been detected in the CIU.
CTVS FAIL	NONE A failure has been detected in the CTVS. HUD video recording on the AVTR and HUD video to the rear cockpit of TA-4 may be lost.

AL 8(7)

Table 5-11 Fault Annunciations and Required Actions (Continued)

HUD Annunciation	REQUIRED ACTION / Explanation
DADC FAIL	IF HUD DADC INFORMATION IS INVALID DISCONTINUE AFCS OPERATIONS AND REVERT TO HEAD DOWN OPERATION. A failure has been detected in the DADC. Refer to paragraph 5.126 DADC FAILURE.
DISPLAY UNIT	SELECT VIDEO DISPLAYED AS NEEDED USING REMAINING OPERATIONAL DU A failure has been detected in one of the DUs
DP BATTERY	NONE The DP battery used to retain data during power off periods has failed. Backup navigation is lost if power is removed from the DP.
DP FAIL	OBSERVE DUs FOR EVIDENCE OF IMPROPER OPERATION. DISCONTINUE USE OF ANY AFFECTED NAS FUNCTION A major failure has been detected in the DP. Refer to paragraph 5.117 DP FAILURE.
DP SYMBOLS	OBSERVE DUs FOR EVIDENCE OF IMPROPER SYMBOLOGY. A character generator failure has been detected in the DP.
HUD	OBSERVE HUD FOR EVIDENCE OF IMPROPER OPERATION. REFER TO HEAD DOWN INSTRUMENTS IF REQUIRED. SELECT HUD STBY RETICLE FOR DVTS BOMB DELIVERY OR REVERT TO MANUAL WEAPON DELIVERY. A failure has been detected in the HUD.
INU ATTITUDE	DISREGARD HUD ATTITUDE INFORMATION. USE ADI AND STANDBY COMPASS IF REQUIRED A major failure has been detected in the INU. Refer to paragraph 5.121 INU FAILURE.
INU NAVIGATION	NONE A failure has been detected in the INU. NAS and OFFSET NAVAID are inoperative. Weapon Delivery degraded. Refer to paragraph 5.121 INU FAILURE.
MUX BUS FAIL	NONE A single 1553 bus failure has been detected.
RADAR ALT	SELECT RAD ALT OFF A failure has been detected in the radar altimeter. Radar altimeter data is no longer available.
RADAR DEGRADED	OBSERVE RADAR FOR EVIDENCE OF IMPROPER OPERATION. IF IMPROPER OPERATION IS EVIDENT, SELECT ANOTHER RADAR MODE A minor failure has been detected in the radar.
RADAR FAIL	OBSERVE RADAR FOR EVIDENCE OF IMPROPER OPERATION. DISCONTINUE USE OF ANY AFFECTED RADAR FUNCTION A major failure has been detected in the radar.
SCS LEFT SIU	NONE A failure has been detected in the left SIU of the SCS. AIM-9 missile launching from stations 1 or 2 is no longer available.
SCS RIGHT SIU	NONE A failure has been detected in the right SIU of the SCS. AIM-9 missile launching from stations 4 or 5 is no longer available.
SCS MPPU	NONE A failure has been detected in the MPPU of the SCS. AIM-9 missile launching is no longer available, except using MANUAL WEAPONS.
TACAN FAIL	ATTEMPT MANUAL OPERATION USING TACAN CONTROL PANEL A failure has been detected in the TACAN system or the CIU. TACAN data may be lost.
VOR/ILS FAIL	SELECT VOR/ILS OFF A failure has been detected in the VOR/ILS system. VOR/ILS data is no longer available.

AL 8(7)

FLIGHT CONTROLS SYSTEMS FAILURE

Jammed Controls

5.130 Icing would be the most likely cause of jammed controls. If this occurs, **DO NOT** pull the disconnect and attempt to fly using manual control, but proceed as follows:

1. Strike stick smartly; attempt to free controls.
2. If unable to free controls, fly the aircraft with trim to an altitude below the freezing level, and repeat step 1.

CAUTION

The flight control hydraulic system must not be disconnected with a hydraulic system functioning if the flight controls appear to be jammed or malfunctioning.

3. If aircraft becomes uncontrollable ... **EJECT**

Horizontal Stabilizer Actuator Failure

5.131 If the stabilizer actuator should fail while the aircraft is trimmed for high speed flight, there may be insufficient nose up elevator authority at low speed with forward CG, and flaps extended. Refer to **LANDING FULL: NOSE DOWN TRIM**.

Horizontal Stabilizer Trim Runaway During Flight

5.132 Procedure.

- 1.* **RAT** **DEPLOY**

WARNING

Do NOT disconnect flight control system.

2. Manual Trim Override **RETRIM**

3. If unable to retrim and trim is stuck at or near full noseup position:
 - a. Reduce speed
 - b. Lower flaps
 - c. Use bank, as required, to control nose attitude.
4. Burn down/dump to land.

NOTE

If runaway trim occurs at high airspeed, aircraft G loading will rapidly increase as the trim approaches full noseup. If control stick is not restrained it may move fully forward due to effect of bobweight.

Landing: Full Nose Down Trim

5.133 If a landing must be made with full **NOSEDOWN** trim that cannot be corrected by the use of the horizontal stabilizer **MANUAL OVERRIDE**, proceed as follows:

1. Flaps **UP**
2. Max aft CG **TA-4: Max landing weight**
A-4: 600 lbs fuel
3. Cautiously reduce airspeed to a reasonable approach speed. Fly IAS that ensures additional backstick movement of at least 2 inches for use if gusts or turbulence cause a nosedown pitch during the approach. (Extending the flaps will only reduce the amount of backstick available).
4. Make straight in approach.

Landing: Full Nose Up Trim

5.134 If a landing must be made with full nose up trim that cannot be corrected by the use of the Horizontal Stabiliser **MANUAL OVERRIDE**, proceed as follows:

1. Flaps **FULL DOWN**
2. Moderate forward stick pressure required.
3. Straight in approach recommended.

AL 8(7)

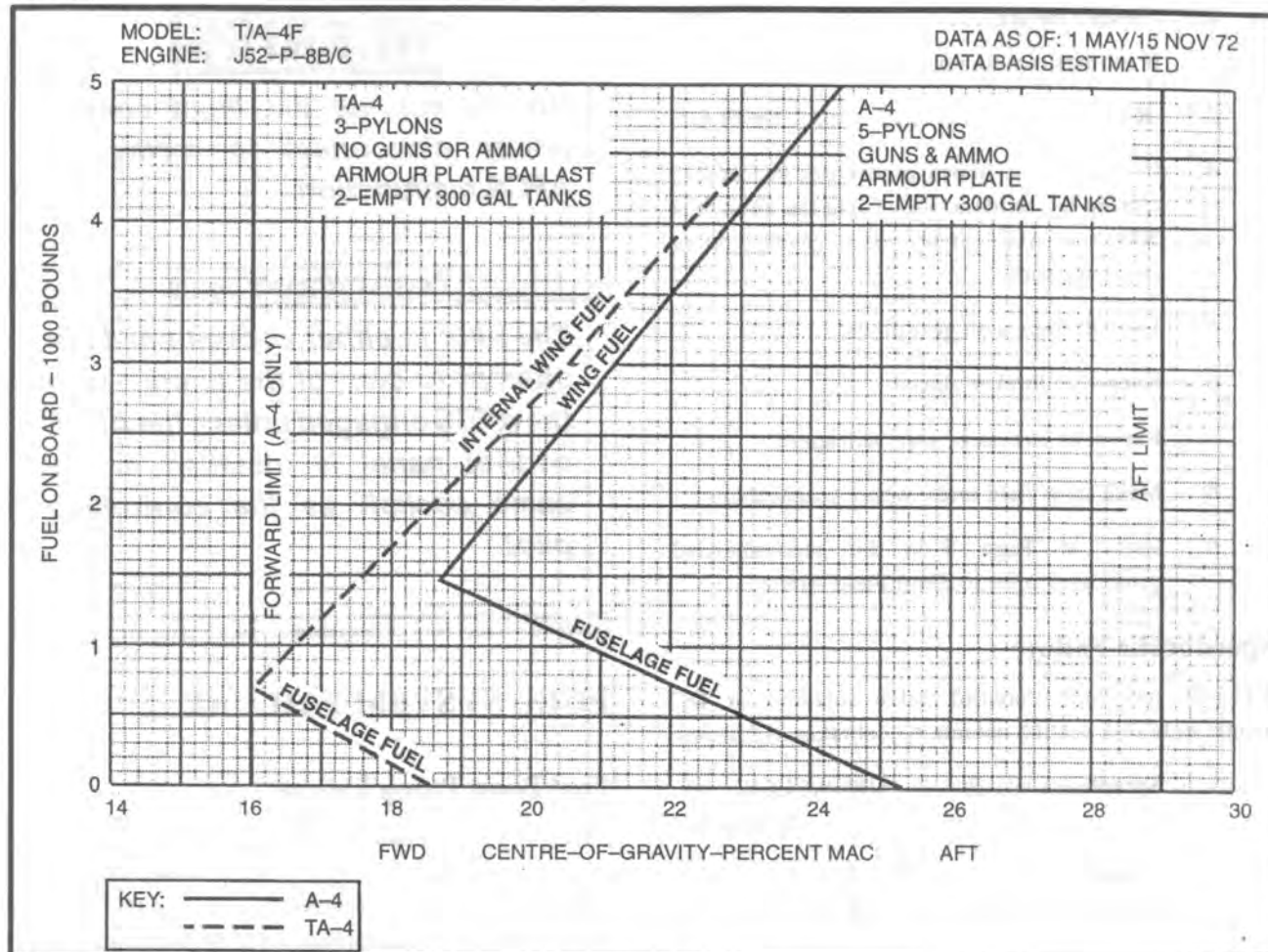


Figure 5-7 Typical CG Travel: Gear and Flaps Down

Normal Aileron Trim Failure

5.135 If aileron trim fails to respond while attempting normal corrective trim, do not attempt to check the trim circuit by operating the trim switch in the opposite direction. This will only make the out of trim condition worse.

Aileron Trim Runaway

5.136 Procedure.

- 1.* RAT DEPLOY
2. Burn down/dump and land.

5.137 With trim jammed at maximum deflection in either direction, force required to return stick to neutral will be moderate.

WARNING

Do NOT disconnect flight control system.

5.138 At high speeds on manual control, lateral forces will be uncontrollable if the aileron trim has runaway.

Rudder Trim Runaway

5.139 Procedure.

- 1.* RAT DEPLOY
2. Burn down/dump to land.

5.140 Force required to return rudder to neutral will be moderate.

WARNING

Do NOT disconnect flight control system.

Spoiler Malfunction

5.141 If spoilers deploy in flight, proceed as follows:

- 1.* Throttle ABOVE 70 %

NOTE

Potential inflight deployment when the power is reduced below 70 percent with the spoilers armed may be indicated by unlighted AOA indexers with the landing gear down.

AL 8(7)

- 2.* Spoiler switch OFF

If spoilers remain up, proceed as follows:

- 3.* RAT DEPLOY

4. If none of the above procedures succeed in closing the spoilers, slow flight the aircraft at 5000 feet AGL, or above, to check landing characteristics.
5. Use full flaps with gear down.
6. Keep speedbrakes closed.
7. Expect an excessive approach speed.
8. Make short field arrest where practicable.
9. Refer to Page 5-48 for recommended procedures prior to Short Field Arrest.

Speedbrake Failure

5.142 If speedbrake control valve solenoid or DC electrical failure occurs, operate speedbrakes as follows:

1. Speedbrake switch OPEN/CLOSE, AS REQUIRED
2. Emergency PULL TO OPEN, OR speedbrake knob PUSH TO CLOSE

5.143 The emergency speedbrake control may be used to override the electrical signal, but the handle must be held in the desired position. In case of hydraulic and electrical failures when the speedbrakes are open, they may be closed to the trail position by momentary actuation of the manual control.

AFCS MALFUNCTION

5.144 In the event the flight controls operate in an erratic manner, such as uncontrolled lateral or pitch oscillations, or a "hard over" condition occurs, whether operating with AFCS in STANDBY or OFF, proceed as follows:

1. Depress the autopilot override button on the control stick.
2. If normal control is not restored and AFCS standby switch is in STANDBY, switch the AFCS OFF.
3. If this does not restore normal conditions, deploy the emergency generator.
4. If normal aileron trim is not restored upon disengagement of the AFCS, move the AFCS aileron trim NORM/EMER switch to EMER position.

WARNING

Do not actuate the flight control power disconnect to rectify an AFCS malfunction.

TA-4 AIRCRAFT ONLY

The pilot in either cockpit shall not attempt to control the aircraft with the AFCS engaged unless the AFCS control panel is installed in the same cockpit as the controlling pilot.

FUEL SYSTEM FAILURE

Fuel Boost Pump Failure

5.145 With an inoperative boost pump, gravity flow of fuel to the engine driven fuel pump provides an adequate supply of fuel for all power conditions up to 6,000 feet, and for continued operation at reduced RPM at higher altitudes.

NOTE

Above 25,000 feet, throttle should be at 90% or less.

There have been repeated instances of successful full power operation at 35,000 feet.

5.146 If boost pump fails proceed as follows:

1. Throttle Minimum required
2. Avoid zero G, negative G, or inverted flight.
3. Ensure positive G loading during speedbrake operation.
4. LASAPRAC.

Fuel Quantity Indicator Failure

5.147 If the indicator needle will not move or if it continuously rotates, manage the fuel, using the flowmeter and the best estimate of fuel remaining. If in company with other aircraft with similar fuel load and mission profile, the fuel remaining will usually be within a few hundred pounds of that of the accompanying aircraft. Land as soon as practicable, in either case.

AL 8(7)

NOTE

The LOW FUEL warning light will still provide indication of a low fuel state.

Fuel Transfer Failure

5.148 This could result from a failure of the Transfer Pump, indicated by a steady illumination of the FUEL TRANS light with fuel remaining in the wing tank; or failure of the Fuselage Tank Fuel Transfer Shut Off Valve.

NOTE

The FUEL TRANS caution light may come on during manoeuvring flight, when the engine rpm is approximately 70 percent or below, or if the wing fuel is depleted.

Prolonged nose down attitudes with low wing fuel states may cause unporting of the fuel transfer pump resulting in a FUEL TRANS caution light. Continued depletion of fuselage fuel will then result in activation of the low level switch (thermistor bead) causing the low fuel warning light to illuminate and internal fuel contents to read only the actual fuel remaining in the fuselage tank.

5.149 If the Fuselage Tank Fuel Transfer Shut Off Valve fails in the closed position, the FUEL TRANS caution light will not normally illuminate. However, indication of such a failure will be an abrupt drop in fuel quantity indication to approximately 550 pounds (TA-4) 1100 pounds (A-4), with the associated illumination of the LOW FUEL light. With fuel remaining in the external tanks and drop tank pressurization selected, fuel will continue to transfer to the fuselage tank through air refuelling plumbing, hence an abrupt drop in quantity will not normally occur until external fuel is depleted. Whenever the fuel quantity drops unexpectedly or the FUEL TRANS caution light remains on, assume that the usable fuel remaining is either 650 pounds (TA-4), 1400 pounds (A-4), or the indicated fuel quantity, whichever is less and proceed as follows:

If fuel remains in the drop tanks:

1. Drop Tank Transfer switch PRESS
After drop tank transfer is complete:
2. Emergency Transfer switch , EMER TRANS

NOTE

With centreline tanks leave drops pressurized.

With the air refuelling store installed:

3. Ship Tank Switch FROM STORE
4. LASAPOSS.
5. Emergency Transfer switch OFF prior to landing

5.150 With the emergency transfer switch in EMER TRANS position, a static pressure of 6 psi is imposed in wing tank. Inadvertent dumping of wing tank fuel may occur through a pressure relief and dump valve if the wing tank is overfilled or wing tank vent becomes blocked with fuel. Inadvertent dumping of fuel will be apparent from a rapid drop in fuel quantity indication (about 700 lbs per minute). It may be necessary to turn off the emergency transfer switch temporarily to permit a decay of wing pressurization and the dump valve to reseal. This uncommanded dumping of wing fuel may also be caused by over pressurization of the wing tank due to drop tank transfer bleed air entering the wing.

5.151 A stuck float valve may be unseated by rapid oscillation of the control stick within the structural limits of the aircraft. This should be done before selecting EMER TRANS. If this action unseats the valve, landing at the nearest suitable facility is still recommended as there is a possibility that the valve will stick again.

Drop Tank Transfer Failure

5.152 If fuel transfer from all drop tanks is abnormally slow or fails during flight, proceed as follows:

1. Drop Tank Transfer switch PRESS
2. Emergency Transfer switch OFF
3. Air Refuelling switch NORMAL
If drop tank transfer still does not occur:
4. RAT DEPLOY

NOTE

Unless the drop tank fuelling switch in the Aft engine compartment is placed in the OFF position after refuelling the drop tanks, drop tank fuel transfer will not occur unless the emergency generator is deployed.

AL 8(7)

5.153 When drop tank transfer is complete, place emergency generator switch in BYPASS. If deploying emergency generator does not accomplish transfer:

5. Ensure aircraft weight for landing does not exceed maximum limits. Make minimum descent landing.

NOTE

If it is apparent that one drop tank is not transferring while others are functioning normally, the fuel contained in the failed tank should be considered unusable. No airborne remedial action is available.

If an air refuelling store is installed, no fuel will be transferred from the store to the wing unless the tank is selected FROM STORE. Selecting FROM STORE will then pressurize all drop tanks regardless of the position of the Drop Tank Transfer Switch.

Uncommanded Fuel Dumping

5.154 Uncommanded fuel dumping may occur due to over pressurization of the wing fuel cell (greater than 8.5 to 9.0 psi) which can be caused by either blocking the Pressure & Vent valve with fuel while EMER TRANS is selected or by drop tank transfer bleed air which can enter the wing when external tanks are empty but pressurization remains on. If the dump valve is opened in this manner, it will not close until pressure in the wing decreases to about 4 psi. Whenever uncommanded fuel dumping is experienced, or if fuel dumping does not stop when deselected, proceed as follows:

1. Drop Tank Pressurization switch OFF
2. Emergency Transfer switch OFF
3. While wing fuel remains, proceed at highest feasible speed to nearest suitable divert. If distance warrants, fly BINGO profile (modified as necessary).

4. Obtain visual inspection if possible.

If fuel is from dump mast then:

5. Wing Fuel switch Cycle to DUMP for 10 to 20 seconds in attempt to clear dump valve

NOTE

A nose low, left wing down sideslip, that shifts fuel away from the dump valve, may reduce wing tank pressure, allowing valve to reseal (if dump was commenced due to over pressurization of the wing tank).

If fuel is from vent mast then:

6. Apply +ve and -ve G in an attempt to reseal the fuel transfer shutoff valve.

If dump continues and fuel remains in external drop tanks, drop tank fuel can be obtained as follows:

7. Air Refuelling switch FUSE ONLY
8. Drop Tank Transfer switch PRESS

Fuel Leak

Fuel Leak from Fuselage Area

5.155 Possible sources of a fuel leak from the fuselage area are fuel control fuel heater, (fuel pump, oil cooler, and fuel manifolds. A fuel leak from these areas may not be detected by cockpit engine instruments and fire or engine flame out can occur.

5.156 If a wingman verifies a fuel leak from the fuselage area, proceed as follows:

1. Throttle MINIMUM REQUIRED FOR FLIGHT
2. LASAPOSS via a precautionary approach.
3. Be alert for fire.
4. Closely monitor engine instruments.

Fuel Leaking from Wing Tank

5.157 If fuel is leaking from wing tank proceed as follows:

1. Drop Tank Pressurisation switch OFF
2. Emergency Transfer switch OFF
3. While wing fuel remains, proceed at highest possible speed to nearest divert airfield. If distance warrants, a bingo profile should be flown modifying (increasing) airspeed as required.
4. Once wing fuel is depleted, continue flight at maximum range cruise. Intercept bingo profile for final descent.

If fuel remains in drop tanks.

5. A-4: Air Refuelling switch . . FUSE ONLY
TA-4: Fuel Transfer
Normal/Bypass switch BYPASS
6. Drop Tank Transfer switch PRESS

AL 8(7)

*Fuel Leaking from Fuselage Fuel Tank***WARNING**

Fuel leaking from fuselage fuel tank has resulted in explosion. Ejection should be considered depending on severity of fuel leak.

5.158 If flight is continued proceed as follows:

- I 1. LASAPOSS.
If fuel quantity drops to 550 pounds:
2. Emergency transfer – CYCLE TO MAINTAIN QUANTITY AT 550 POUNDS.

NOTE

Leaving emergency transfer on may result in accelerated fuel loss.

ENVIRONMENTAL SYSTEM FAILURES

Oxygen System Failure

5.159 If no oxygen is available because of system depletion or failure, or if mask malfunctioning or contaminated oxygen is suspected, proceed as follows:

- 1.* Emergency Oxygen (Green Ring) . PULL
- 2.* Main Oxygen Hose DISCONNECT Connection
3. Cabin Altitude ... Descend to 10,000 feet or below.
4. Oxygen Supply OFF
5. When emergency oxygen is depleted or significant restriction to breathing is felt, REMOVE MASK and remain below 10,000 feet cabin altitude.

Hypoxia Symptoms

5.160 If hypoxia is suspected in flight proceed as follows:

1. Oxygen Regulator ... 100% / EMERGENCY
2. Main Oxygen Hose CONNECTED
3. Flow Indicator CHECK

5.161 If steady white or black, proceed as for Oxygen System Failure.

Air-Conditioning Temperature Control Failure

5.162 Most NORMAL position temperature failures can be corrected by use of the MAN COLD or MAN HOT positions.

5.163 If the cockpit temperature is excessive and does not respond to normal or manual temperature commands proceed as follows:

1. Cabin Press RAM
(Altitude 25000 feet maximum)
- I 2. LASAPRAC.

5.164 As a last resort the canopy should be jettisoned, if doing so would improve the situation.

LOSS OF CANOPY

5.165 Canopy loss in flight may result in structural damage from the canopy hitting the aircraft. At speeds in excess of 200 KIAS, windblast will be the primary problem, however, the pilot will be able to effectively screen himself from the wind by leaning forward and will have no difficulty in controlling the aircraft. In the TA-4 the rear seat occupant will experience severe physical buffeting due the force of the airflow. There is a strong probability that at speeds above 200 KIAS his oxygen mask may be forced up covering his eyes. Radio and ICS communications will be satisfactory from the front cockpit, but the aft seat occupant will be unable to communicate at speeds in excess of 200 KIAS.

5.166 It is unlikely that windblast alone will pull the rear seat face curtain if the face curtain handle is properly seated. However, if the handle is slightly dislodged, it is possible that at speeds above 220 KIAS the windblast will pull the face curtain and fire the seat. Should the face curtain handle become dislodged, at speeds above 250 KIAS, it is probable that the ejection seat will fire inadvertently.

AL 8(7)

WARNING

Aircrew should not take any action that might cause a hand to be caught in the windstream. It is likely an arm flailing in the windstream will hit the face curtain handle causing partial dislodgement of the handle thereby increasing the possibility of inadvertent ejection.

5.167 For loss of canopy proceed as follows:

1. Airspeed Reduce Below 200 KIAS
2. Seat LOWER
3. Altitude Descend to achieve acceptable cockpit temperature
4. LASAPRAC.

TA-4 AIRCRAFT ONLY**WARNING**

In the TA-4, if the canopy separates from the aircraft while airborne, the pilot in the front seat will retain, or immediately assume control of the aircraft. The rear seat occupant should prepare for possible ejection.

WARNING

After canopy loss or jettison, be alert for excessive flapping of the face curtain. If such a condition develops, reduce airspeed as required.

AIR REFUELLING STORE FAILURE

Hose Jettison

5.168 Hose jettison may be desirable when store hydraulic pressure is lost or when an electrical malfunction occurs which prevents retraction of the drogue, and a hose extended landing is not practical.

1. Proceed to safe area.
2. Airspeed reduce to 250 KIAS or less.

NOTE

If hose jettison is accomplished at speeds in excess of 250 KIAS, excessive tension on the hose due to hose stretching may pull the hose from the crimper after the guillotine is fired.

3. Hose Jettison Switch JETTISON

WARNING

Do not change position of hose jettison switch after jettisoning hose and drogue.

NOTE

A 5-20 second time delay will occur prior to the hose jettisoning.

Electrical Failure

5.169 Should the main generator or store electrical system fail with the drogue extended, transfer to the receiver aircraft will terminate automatically. All external fuel will transfer to the wing fuel tank. The Store Air Turbine will feather automatically, and store hydraulic power will be lost. The only refuelling store function available on the RAT is Hose Jettison. Remaining store fuel cannot be dumped, and the drogue cannot be retracted.

1. Make STRAIGHT-IN approach with hose extended. Inset threshold by 1,000 feet.

NOTE

If, due to a compound emergency, an arrested landing is required, or, if fuel/range is a consideration, hose jettison or store jettison in a safe area may be required.

5.170 If a compound emergency is experienced that requires an arrested landing or fuel/range is a consideration, hose jettison should be attempted in a safe area. Store jettison may be an option if an emergency situation so dictates.

AL 8(7)

Store Hydraulic Failure

5.171 Any evidence of a hydraulic leak observed during refuelling operation proceed as follows:

1. Refuelling CEASE IMMEDIATELY operations
2. Drogue Position Switch RET
3. Refuelling Master Switch OFF

5.172 If all store hydraulic pressure is lost it will not be possible to retract the hose. To feather the hydraulic turbine while the drogue is extended proceed as follows:

4. RAT DEPLOY

NOTE

At night or in IMC, attempt to gain VMC prior to extending the emergency generator to avoid compounding the emergency.

Deploying the Emergency Generator causes the hydraulic turbine to feather and disables all but the hose Jettison function on the Refuelling Store.

5. Air Refuel master switch OFF
6. Emergency Generator
Bypass switch BYPASS
7. Make STRAIGHT-IN approach with hose extended. Inset threshold 1,000 feet.

If fuel consumption is critical, consider jettisoning the hose and drogue to reduce drag.

Drogue and Coupling Lost and/or Hose Severed

5.173 Should the basket or hose be lost, the remaining hose will automatically retract due to the loss of the drag created by the basket. The following procedure is recommended:

1. Drogue Position switch RET
2. RAT DEPLOY
3. Refuelling Master switch OFF
4. Emergency Generator
Bypass switch BYPASS

NOTE

The store fuel may be dumped, but the refuelling master switch must not be placed in ON.

5.174 The preceding procedure is recommended to reduce fire hazard created by the loss of the hose. A secondary procedure is as follows:

1. Drogue Position switch RET
2. Hose Jettison switch JETTISON

Loss Of Store Feathering Control

5.175 If unable to feather the store air turbine after drogue retraction, proceed as follows:

1. Check drogue position indicator:
 - a. RET SLOW TO
300 KIAS/0.80 IMN
 - b. TRA SLOW TO
(but drogue retracted) 230 KIAS
AND RECYCLE
2. If unable to retract hose SLOW TO
200 KIAS/0.80 IMN
FOR REMAINDER
OF FLIGHT

After landing, hose may trail out and sustain damage. With the store unfeathered and drogue indicating EXT/TRA, the drag index is greatly increased. If fuel consumption is critical, JETTISON hose.

LANDING EMERGENCIES

LANDING WITH LANDING GEAR MALFUNCTIONS

5.176 Table 5-12 provides guidance for emergency landings with landing gear malfunctions. These are recommendations only and are based on experience and statistical data available to date.

Emergency Landing Gear Extension

5.177 Utility hydraulic system failure will necessitate lowering the landing gear with the emergency release system as follows:

1. Airspeed 225 KIAS OR LESS
2. Emergency Jettison Selector SELECT
EMPTY STN
3. Landing gear handle DOWN

TA-4 AIRCRAFT ONLY

NOTE

If circuit power to the retraction release switch has also failed, the downlock release latch must be manually moved to the aft position before the landing gear handle can be moved to DOWN.

4. Emergency landing gear PULL
release handle

WARNING

Activation of the emergency landing gear release handle may cause inadvertent jettison of external stores. Avoid populated areas.

5. If landing gear fails ... APPLY MODERATE
to extend NEGATIVE G LOADING
 FOR 2 -3 SECONDS.
 OBTAIN VISUAL CHECK

If landing gear still does not extend fully or lock down:

6. Airspeed INCREASE (350 KIAS MAX)
 AND APPLY +G.
 OBTAIN VISUAL CHECK

5.178 After lowering the landing gear by the emergency release system, the gear handle should be left in the DOWN position until the ratchet in the emergency system has been reset. This procedure should be followed to prevent a failure of the ratchet and damage caused by premature closing of the gear doors. However, if utility system pressure is available and circumstances warrant, the landing gear can be raised by means of the landing gear handle.

UNSAFE GEAR DOWN INDICATIONS

5.179 The most likely causes of failure of the landing gear to indicate DOWN after completion of the gear extension cycle are: faulty microswitches, sticking gear position indicator, utility hydraulic system failure, hung gear due to improper strut servicing, or failure of the main landing gear actuating cylinder. If all gear remain UNSAFE or UP with the gear handle down, the utility hydraulic system has most likely failed. Use the emergency landing gear extension procedure.

Main Landing Gear Unsafe, Gear Handle Down

1. Airspeed Maintain 225 KIAS or less.
2. Obtain Visual Inspection.

NOTE

Unsafe gear down indication may be the result of a malfunctioning microswitch within the gear indicating system. A visual check is required to determine whether the landing gear is actually unsafe. The WHEELS Warning light and the light in the Gear Handle should also be checked since if these are not illuminated it is likely that the gear is locked down. Illumination of AOA indexer lights generally indicates that the left main gear is down.

A positive inflight check that the main gear is locked down is achieved by observing that the overcentre lever at midpoint of drag links is positioned forward and parallel to lower surface of wing.

3. If inflight check confirms gear locked down, land. A short field arrest is recommended, however if this is not available, make a normal approach and landing.

AL 8(7)

4. If a visual check reveals that one or more of the landing gear doors remains closed, proceed with Emergency Landing Gear Extension.

NOTE

If all the landing gear doors are open, do not use the emergency landing gear release unless a visual check is unavailable and previously employed procedures have failed to produce a safe indication, as the emergency release simply unlatches the doors.

5. If a visual inspection is not available or, if the gear appears to be down but this cannot be confirmed (night, wing stores obstructing view) RECYCLE the gear in an attempt to obtain a DOWN indication.

CAUTION

If extension of the landing gear is accompanied by an abnormal thump and subsequent loss of utility hydraulic pressure, suspect a main landing gear trunnion failure and DO NOT cycle the gear to obtain a locked down indication. Refer to Figure 5-8. If all three gear indicate unsafe with the gear handle down and normal utility hydraulic pressure, cycling of the landing gear could result in damage to the gear doors or possibly a hung gear because of improper sequencing of the landing gear system.

6. Apply positive G to correct a possible microswitch malfunction.

NOTE

Increased G will increase the force available to lower the gear and, if the cause is a faulty microswitch, may seat the microswitch and enable a DOWN indication.

7. If the gear is up but the doors are open, raise the gear handle and proceed as follows:
 - a. Apply and maintain negative G.
 - b. Speed Brakes EXTEND
 - c. Gear handle DOWN

NOTE

Improper strut servicing or brake lines catching on obstacles in the wheelwell may cause the main landing gear to hang up in wheelwell. In this situation the gear doors will be open.

8. If the above procedures fail to achieve a locked DOWN indication, or if the gear is partially extended, increase airspeed to a maximum of 350 KIAS and apply positive G. Particular attention must be made to keep the aircraft in balance.
9. If landing gear still indicates UNSAFE, but the gear appears to be down, make a short field arrest. To ensure that gear is safely locked down, have the landing gear safety pins fitted before taxiing to dispersal.

NOTE

Gear pins cannot be installed unless the gear is locked down.

10. If, after attempting above procedures, the gear is still partially extended or UP, or if an arrested landing is not practicable, attempt to raise the landing gear (provided utility hydraulic pressure is available). Refer to Emergency Landing With Gear Malfunctions Table.

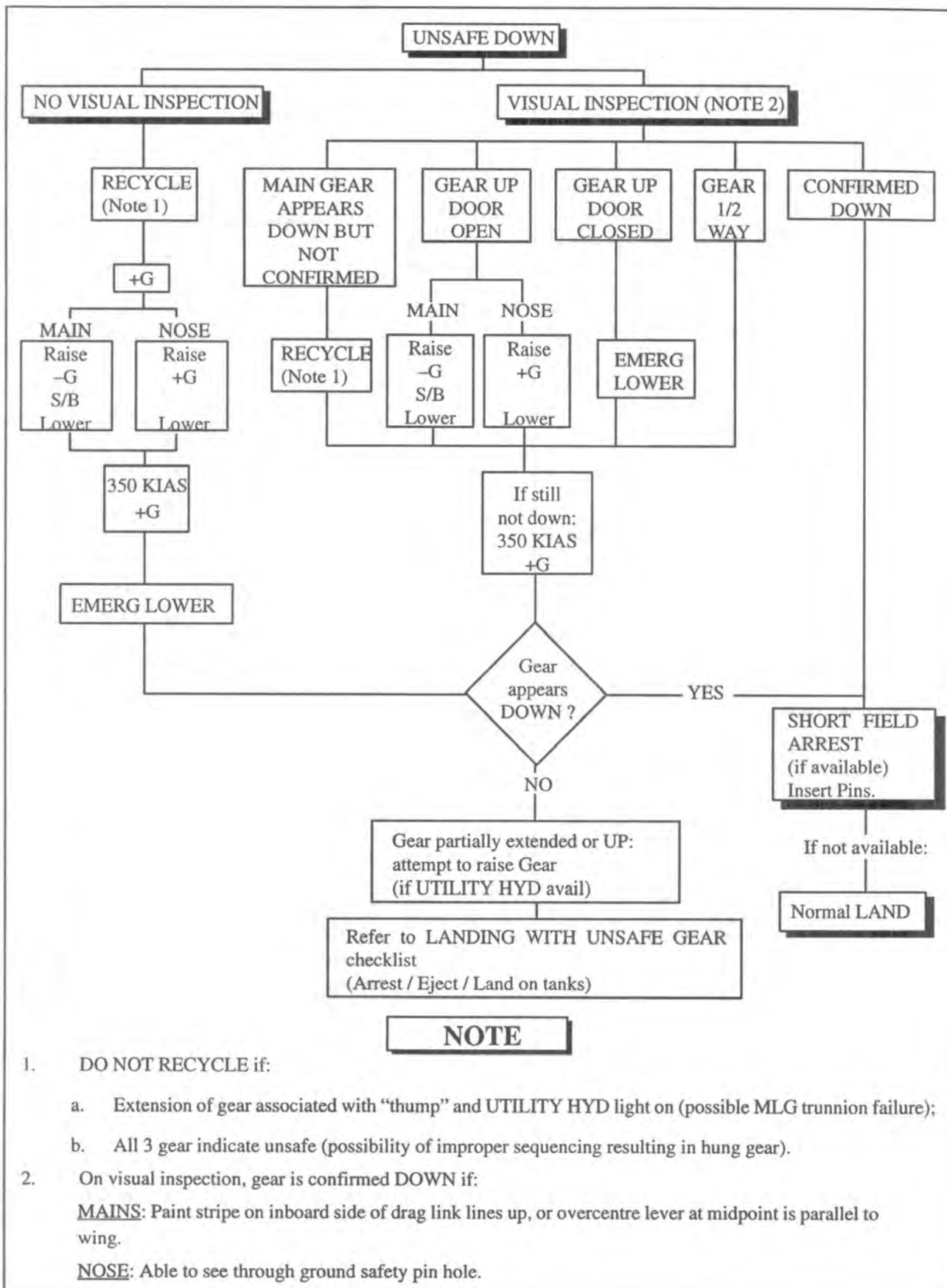


Figure 5-8 Unsafe Gear

AL 8(7)

Table 5-12 Emergency Landing With Gear Malfunctions

	ARRESTOR GEAR AVAILABLE				
	YES			NO	
FINAL CONFIGURATION	LAND or EJECT	USE ARRESTOR GEAR?	NOTES	LAND or EJECT	NOTES
All Gear Up	LAND	NO	1,2	LAND	1
Nose Gear Up; Main Gear Safe	LAND	YES	3	LAND	5
Stub Nose Gear; Main Gear Safe	LAND	YES	3	EJECT	
One Main Gear Up; One Main & Nose Gear Safe	EJECT	NO	4	EJECT	
Stub Main Gear; One main & Nose Gear Safe	EJECT	NO		EJECT	
Nose & One Main Gear Up; One Main Gear Safe	EJECT	NO		EJECT	
Both Main Gear Up; Nose Gear Safe	LAND	YES	6	LAND	6

NOTE

1. Make flat approach at optimum approach speed. Touch down lightly with low sink rate. If crosswind component exceeds 10 knots a short field arrest is recommended.
2. Alternate Method: Use arrestor gear, go around if the wire is missed.
3. Make a short field arrest from a flat approach at optimum angle of attack plus 10 knots, with flap down and 1,500 pounds of fuel. At touchdown, hold the nose up and do not retard the throttle until the arrest. Go around if the wire is missed.
4. An alternative to ejection for this condition is to land in an approach similar to Note 3, except burn down to 600 pounds of fuel and touch down immediately prior to the arrestor gear. Grease the aircraft on and hold the wings level with aileron as long as possible.
5. Make a flat approach at optimum approach speed. Trim full NOSE UP approaching touch down. At touch down shut down engine. Lower the nose before elevator effectiveness is lost.
6. Ejection is mandatory unless two drop tanks are fitted.

5.180 Whenever any landing gear is damaged or not locked down, attempt to retract all gear. Retain empty tank(s), empty rocket pods, or other lightweight inert stores with the exception of an air refuelling store. Jettison drop

tanks if they cannot be emptied. Burn down to 600 pounds, or less, fuel remaining, to ensure that wing fuel is expended and fire hazard minimized. Proceed as follows:

AL 8(7)

Nose Gear Unsafe

5.181 The actions for Nose Gear UNSAFE are the same as for Main Gear UNSAFE, except in the case described below.

5.182 The nose gear may hang up in the wheelwell due to improper strut servicing or a broken telescoping mechanism. The gear will be up with the door open. If this situation exists and the preceding procedures have not produced a safe indication, or if a visual inspection is not available, raise the Gear handle and proceed as follows:

1. Apply and maintain positive G.
2. Gear handle DOWN

NOTE

Visual confirmation that the nose gear is locked DOWN can be made by sighting through the ground safety pin hole.

NOTE

When cycling the gear, nose wheel extension may require as much as two minutes because of back pressure in the return line if the cause is a broken nut in main landing gear actuating cylinder.

FIELD ARRESTS

5.183 Many types of field arrestor gear are in service, all of which differ in the limits for their employment. (Refer to Table 5-14).

WARNING

Engagement of unidirectional arrestor gear in the wrong direction may cause severe aircraft damage.

5.184 Field arrestor gear is classified according to its location on the runway.

1. Short Field gear: Located 1500 to 2500 feet from the approach end threshold.
2. Midfield gear: Located near the halfway point of the runway.
3. Abort gear: Located 1500 to 2500 feet short of the upwind end of the duty runway and will usually be rigged for immediate use.

4. Overrun gear: Located past the upwind end of the runway. It will usually be rigged for immediate use.
5. Jet Barriers: A cable or net barrier rigged in the overrun area.

CAUTION

Use of the Jet Barrier is not recommended.

5.185 Engagement of field arrestor gear should be made at the minimum speed practicable, on and parallel to the runway centreline. Engagement should be accomplished with feet off the brakes, harness locked, and all three wheels on the ground.

WARNING

If off centre conditions are encountered approaching the arrestor gear, do not attempt to regain the runway centreline; engage the arrestor gear tracking parallel to the runway centreline.

Short Field Arrests

5.186 The short field arrest provides minimum roll out and minimum directional control problems while retaining go around capability if the wire is missed.

5.187 Short or midfield gear should be utilised when available.

5.188 The following procedures are recommended prior to a short field arrest:

1. Reduce weight to 14,500 lbs maximum where possible, and configure as follows:
 - a. Ensure no fuel remains in the drop tanks or buddy store.
 - b. Maximum store load of 1200 lbs on stations 2 or 4.
 - c. Maximum permissible asymmetric moment of 7500 ft lbs.
 - d. No loaded MER on station 3.
 - e. Empty rocket pods only on station 3.
2. Advise Tower.
3. Obtain a visual check that the hook is down.

AL 8(7)

4. A straight in approach is preferable. Approach at a speed (AoA) commensurate with aircraft weight and type of emergency.
5. Aim to touchdown 300 ft short of the wire, on the centreline. If a severe directional control problem is anticipated aim to touch down just short of the wire.
6. Hold approach power until arrestment is assured then throttle to idle.
7. Allow the gear to roll out to the fullest extent and pull the aircraft rearward. When the movement stops apply the brakes and wait for the fire crew hand signals.
8. If on an uphill gradient do not allow rearward movement to become too fast prior to braking. Apply with caution.

Long Field Arrests

5.189 The long field arrest is used for stopping the aircraft when the runway remaining is insufficient and when directional control is not a problem. Long field arrest should always be considered on icy or wet runways, aborted takeoffs, loss of brakes during landing rollout, or following high speed approaches. Inform the tower as soon as possible that a long field arrest is to be made.

5.190 Lower the hook 1000 feet prior to the wire to preclude weakening of the hook point. Engagement should be accomplished on centreline, at minimum airspeed, tracking the runway heading. Shutdown of the engine may be accomplished at 80 knots.

Table 5-13 Fire Crew Signals

	Day	Night
1. Brakes On	OPEN PALM AND FINGERS RAISED WITH PALM TOWARDS AIRCRAFT, THEN FIST CLENCHED	CROSSED WANDS
2. Brakes Off	THE REVERSE OF BRAKES ON	CROSSED WANDS, UNCROSSED
3. Hook Up	FIST AND THUMB RAISED TO MEET OPEN HORIZONTAL PALM	VERTICAL WAND RAISED TO MEET HORIZONTAL WAND

Table 5-14 Emergency Arrest Data

Type of Arrestor Gear	Maximum Engaging Speed (Knots)			Maximum off-centre Engagement (Feet)
	Short Field Landing Gross Weight Up to 14,500 Pounds (d,e)	Long Field Landing Gross Weight 14,600 – 16,000 Pounds (f)	Aborted Takeoff Gross Weight 16,100 – 24,500 Pounds (h)	
E-15 (200-Foot Span)	150(b)	150(a)	144(a)	20
E-15 (300-Foot Span)	176(b)	180(c)	174(a)	40
E-27	159(b)	171(c)	163(e)	20
E-28	160(b)	159(a)	150(a)	40
E-28(l)	155(b)	155(a,b)	146(a)	40
M-21	151(a)	151(a)	144(a)	10
BAK-9	160(c)	160(c)	160(c)	30
BAK-12(k)	160(c)	160(c)	160(c)	50
Dual BAK-12(l)	119(b)	133(a)	133(a)	30

NOTE

- a. Maximum engaging speed limited by aircraft arrestor hook strength.
- b. Maximum engaging speed limited by aircraft limit horizontal drag load factor (mass item limit G)
- c. Maximum engaging speed limited by arrestor gear capacity.
- d. Maximum of 3.0 degree glide slope.
- e. Consult appropriate section for recommended approach speed.
- f. Flared or minimum rate of descent landing.
- g. Flared or minimum rate of descent landing.
- h. Data provided in the aborted takeoff column may be used for emergency high gross weight arrests.
- i. Only for the E-28 systems at Keflavik, Bermuda, and Wallops Flight Centre with 920 foot tapes.
- j. Before making an arrestment, the pilot must check with the air station to confirm his maximum engaging speed because of a possible installation with less than minimum required rated chain length.
- k. Standard BAK-12 limits are based on 150 foot span, 1 inch crossdeck pendant 40,000 pound weight setting, and 950 foot runout. No information available regarding applicability to other configurations.
- l. Dual BAK-12 limits are based on 225 foot span, 1-1/4 inch crossdeck pendant, 50,000 pound weight setting, and 1,200 foot runout. No information available regarding applicability to other configurations.

AL 8(7)

Barrier Engagement

5.191 Compatibility of the A-4 aircraft with barrier gear has not been flight tested, but engineering analysis has resulted in the following recommended procedures:

1. Planned use, such as long field arrest, is recommended only when no other type of arrestor gear is available. Do not engage with fuel in drop tanks.
2. Emergency use, such as takeoff abort, would probably be unavoidable because the system is normally rigged. However, the hook should be lowered to increase the probability of arrest.

LANDING : OTHER FAILURES

No Flaps

5.192 When unable to extend the flaps for landing fly a slightly wider pattern (about 1-1/2 miles abeam) and use optimum angle of attack for the final approach and landing. This will give an approach speed approximately 16 to 19 KIAS above the full flap approach speed.

No Speedbrakes

5.193 Utilize the standard pattern entry, approach, and landing. The airspeed will be more sensitive to changes in attitude. In the event of an overshoot, engine acceleration time will be increased, but the overall difference is negligible.

Spoiler Malfunction On Landing Roll

5.194 The spoilers are not interconnected, therefore, there is a remote possibility that only one spoiler will be activated if a spoiler malfunction occurs. This will be indicated by an immediate swerving tendency that may be controlled by application of corrective rudder, ailerons and braking. However, if feasible, the throttle should be advanced to military, a go around effected, and landing accomplished with the spoilers de-armed. If a go-around is not feasible, place the spoiler switch to OFF.

Asymmetric Load

5.195 With an asymmetric load situation the landing should be made so as to put the crosswind component under the loaded or heavy wing, providing other factors are considered (e.g. downwind component, runway length and gross weight). Make a straight in approach. Execute a steady heading sideslip (wing down, opposite rudder) during approach. The minimum approach speed is 115 knots with up to 7500 foot-pounds of asymmetric

moment varying linearly thereafter to 130 knots at 12,500 pounds. Optimum angle of attack should be maintained as long as the resulting airspeed does not become less than the minimum. Normal crosswind limits apply. Landing with any amount of crosswind under the light wing is not recommended due to a considerable reduction in control capability and possible unsafe characteristics during the rollout.

No Airspeed Indication

5.196 Landing with the airspeed indicator inoperative can be accomplished safely. The angle of attack indexer will provide a safe landing approach attitude reference. With the aircraft configured with gear and flaps down, half slat extension will also serve to indicate a safe landing approach speed.

Known Brake Failure

5.197 Landing with one or both brakes inoperative should be treated as follows. If arrestor gear is available, make a short field arrest. Be prepared to go around if the arrestor gear is missed. If arrestor gear is not available, consideration should be given to landing on the longest runway available, wind permitting, aero braking until rudder effectiveness is lost, then utilizing nosewheel steering, if available, for directional control. If one brake is available the aircraft can be stopped on the runway utilizing judicious braking and nosewheel steering. If winds are not favourable, or runway conditions do not permit, or nosewheel steering and/or spoilers are not available, landing wheels up on tanks, racks, or other inert external stores is recommended.

Brake Failure After Touch Down

5.198 When a brake failure occurs after touchdown, go around if possible and proceed as described under Landing: Known Brake Failure. If unable to go around and arrestor gear is available, maintain directional control with rudder and make a long field arrest. Prudent use of nosewheel steering may be desirable at slower airspeeds. If the aircraft is not going to remain on the runway, a decision to jettison inflammable stores, retract the landing gear, and shutdown the engine must be made. Ejection is another feasible alternative.

Nosewheel Steering Malfunction

5.199 If directional control is lost immediately after landing despite corrective inputs, an immediate takeoff is recommended. If the decision is made to continue the landing rollout and a nosewheel steering malfunction is suspected:

1. Maintain corrective control inputs.
2. Actuate stick control button in an attempt to maintain directional control.

AL 8(7)

WARNING

Less rudder deflection is required to counteract crosswind or drift with nose wheel steering engaged. Rudder pedals should be centralized as the nosewheel steering is engaged to prevent excessive swerving or loss of control.

5.200 If depressing stick control button is ineffective:

1. Release stick control button.
2. Maintain directional control by rudder and brakes.
3. Nosewheel steering switch EMER OFF
4. Arrestor hook . . . LOWER 1,000 feet prior to arrestor gear (if necessary)

Blown Main Tyre

5.201 Little difficulty should be experienced in landing with a blown main tyre. If it is known prior to landing that the tyre is blown, a short field arrest is recommended. In crosswind conditions, always use the arrestor gear, if available. Land on the left, right or centre of the runway, depending on crosswind and which tyre is blown. For example, with the left tyre blown, a crosswind from the right, and no arrestor gear available, land on the right side of the runway to provide the maximum distance for aircraft drift during the landing roll. In this case, both wind effect and the increased drag of the blown tyre are additive, tending to drift the aircraft across the runway to the left. If the tyre blows during normal landing rollout, use full rudder, if necessary, and brakes as required to maintain directional control. Usually, a blown tyre will not even be noticeable until 80 knots or less. If the stopping distance appears marginal, shutdown the engine. If abort or overrun gear is available, lower the hook 1000 feet prior to engagement. More braking effectiveness can be obtained from a good tyre than a blown one; consequently, it is poor technique to intentionally blow the good tyre. Nosewheel steering may be used below 60 knots to maintain directional control.

Blown Nose Tyre

5.202 When landing with a blown nose tyre, a short field arrest is recommended. Make practice passes if fuel is available but land at maximum allowable gross weight or as soon as possible thereafter to have maximum aft CG

condition for landing. Make a flat approach at optimum approach speed. Trim full NOSE-UP just prior to touchdown. Touch down with minimum sink rate and hold the nose off until passing over the wires. Do not retard the throttle below approach power setting until the arrest is felt. Go around if the wires are missed. If there is no arrestor gear available, fly the same type of approach; on touchdown lower the nose slowly to the runway before elevator effectiveness is lost, and secure the engine at approximately 80 knots. Little difficulty should be experienced with this landing, with or without arrestor gear available.

Drag Chute Failure

5.203 If the drag chute fails to deploy, proceed as follows:

1. Sufficient runway BRAKING
AS REQUIRED

If the conditions are marginal, due wet runway, short runway, wind or heavyweight:

2. Drag chute STOW/JETTISON
3. Power MILITARY
4. Set up for short field arrest or a no chute landing.

RETRACTION RELEASE SWITCH FAILURE**Ground – Remains In Airborne**

5.204 If the retraction release switch remains in the airborne position during landing, the following services will be inoperative:

1. Spoilers
2. NWS
3. Park Brake

5.205 The following additional services will be affected:

4. Stab Aug will not disengage on touchdown;
5. AOA indexers and transducer heat will remain on;
6. Radar will operate if selected;
7. Elapsed time will continue to run;
8. Chaff/Flare dispenser remains active;
9. IFF continues to operate;
10. Weapon release is possible.

AL 8

FORCED LANDINGS

Landing On Unprepared Surfaces

5.206 Landing on unprepared terrain is extremely hazardous. Provided that sufficient altitude is available, ejection is preferable to attempting an emergency landing on any surface other than a runway. When power is available, more deliberation can usually be given to evaluating the many variables affecting a safe emergency landing, such as direction and speed of the wind, and the type of surface or terrain on which the landing is to be

made. On areas other than prepared runways and surfaces of known adequate hardness, the landing should always be made with the wheels retracted. If the nature of the emergency is such that all wheels will not fully extend, the landing gear should be left in the retracted position. Prior to any wheels up landing on unprepared surfaces all external stores should be jettisoned, except empty drop tanks and lightweight inert stores. A decision to jettison or retain the canopy should be made prior to the landing. Use the normal approach speeds throughout the landing pattern and attempt to touch down at, or slightly above, the normal landing speed.

EMERGENCY EXIT

5.207 Three methods for emergency exit are given, the choice of which depends on the emergency condition. Method 1 is recommended only under extreme emergency conditions where circumstances clearly indicate immediate exit. Methods 2 and 3 are recommended only when time permits.

Method 1

5.208 This method may be used where circumstances clearly indicate immediate exit.

1. Eject. (Refer to Ejection.)

Method 2

5.209 This method may be used when the pilot elects to exit without his parachute and survival gear.

1. Jettison canopy by pulling the CANOPY JETTISON handle.

NOTE

The canopy can be jettisoned with the cockpit canopy control handle in any position.

2. Unfasten the two parachute Koch fittings and the RSSK-8 QRB pin.
3. Unfasten RSSK-8 QRB.
4. Disconnect G suit hose, oxygen hoses and the comms lead.
5. If time permits, safe the ejection seat.
6. Exit from aircraft.

Method 3

5.210 This method may be used when the pilot elects to exit with his parachute and survival gear attached. However, it is not recommended when the height of the jump to the ground may result in injury which would prevent the pilot from moving a safe distance from the aircraft. Also, retaining the parachute and survival kit

unduly restricts body movement, consequently compromising quick exit from the cockpit.

1. Jettison canopy by pulling the CANOPY JETTISON handle.
2. Pull the emergency restraint release handle. This releases the pilot from the seat with the parachute and survival gear attached.
3. If time permits, safe the ejection seat.
4. Exit from aircraft.

Emergency Entrance

5.211 It may be necessary to gain entrance to the cockpit in an emergency to effect the quick and safe removal of the pilot from his seat and parachute. An external control for jettisoning the canopy is provided on each side of the fuselage. Push in on the rescue access door and PULL the canopy-jettison handle that extends; this will jettison the canopy regardless of the position of the canopy or canopy handle.

WARNING

When the canopy is jettisoned, the seat catapult interlock is extracted, requiring extra care to prevent the firing of the seat. Pull the ejection control safety handle down prior to removal of the pilot.

1. To release the pilot from the seat without the parachute and survival equipment attached:
 - a. Unfasten the two parachute Koch fittings and the RSSK-8 QRB pin.
 - b. Unfasten RSSK-8 QRB.
 - c. Disconnect G suit hose, oxygen hoses and the comms lead.

5.212 Pulling the emergency restraint release handle releases the pilot from the seat with the parachute and survival equipment attached.

AL 7(0)

DITCHING

Ditching At Sea

5.213 A forced landing at sea should be made only as a last resort. Ejection is recommended whenever possible. Whenever possible, ditch while power is still available. If power is not available, the pilot must choose between either a high sink rate or increased speed, both extremely dangerous. The difficulty is determining exactly how high to flare above the water without stalling, often without any visual references to assist in height determination. As many as possible of the following should be accomplished if water ditching is imminent:

1. Shoulder harness lock lever LOCKED
2. Landing gear UP
3. Jettison all external stores.
4. Seat MID POSITION
5. Wing flaps DOWN
6. IFF EMERGENCY
7. Transmit MAYDAY position report.
8. Helmet visor DOWN
9. Emergency oxygen PULL
10. All armament switches SAFE
11. Cockpit pressurization RAM
12. Canopy JETTISON
13. Arrestor hook DOWN (to feel for the
water)
14. If engine is running, shut down just prior to impact.

5.214 Land into wind, if there are no swells, and in light seas. Land along the top of and parallel to the swells if they are large roller swells and if the wind is less than 25 knots. Land into the wind in higher force winds to take advantage

of the lowered forward speed, but recognize the possibility of ramming a wave or of striking the tail on a wave crest and nosing in. Maintain sufficient airspeed to flare the aircraft just before touchdown. **DO NOT STALL.** Remain braced until all shocks stop. If not previously accomplished, jettison canopy. Pull emergency restraint release handle to separate from seat with survival gear, and abandon the aircraft as soon as possible.

Underwater Escape

1. Remain braced until all shocks stop.
2. Emergency oxygen PULL
3. Disconnect oxygen hose from left console.
4. CANOPY-JETTISON handle PULL

NOTE

If canopy jettison fails the canopy can be opened manually. In extreme circumstances where impact results in damage that prevents the canopy from being jettisoned or opened by the manual method, escape will necessitate breaking through the canopy. The canopy may be cracked open with the pilot's service revolver or survival knife.

5. Emergency restraint release handle ... PULL
6. Lean forward to clear the parachute past the headrest and to ensure separation of the shoulder harness fittings.
7. When clear of the cockpit, inflate flotation gear.

WARNING

Do not inflate flotation gear until clear of cockpit, as inflated gear may trap the pilot in the cockpit.

EJECTION

5.215 Ejection may be necessary as a result of fire, engine failure, structural failure, midair collision, or when the aircraft becomes uncontrollable. In each case, the pilot must decide when to eject using the following as a guide.

1. Ejection is mandatory under the following conditions, except when unusual circumstances clearly dictate otherwise.
 - a. Serious, uncontrolled fire.
 - b. If the aircraft is in uncontrolled flight at 10,000 feet AGL or below.
 - c. When engine flameout occurs below 1500 feet AGL and 250 KIAS.
 - d. If repeated relight attempts are not successful between 30,000 and 10,000 feet, eject by 10,000 feet AGL.
 - e. If still on first or second relight attempt when passing through 10,000 feet AGL and it appears that a relight is likely, airstart attempt may be continued to a minimum of 5,000 feet AGL.
 - f. Certain landing gear configurations. (See landing gear malfunctions).
2. If the engine flames out below 10,000 feet AGL, zoom to convert excess airspeed to altitude. Attempt an air start if time permits. If the air start attempt is unsuccessful, eject at the apex of

the zoom climb, or 5000 feet AGL, which ever is lower. (See engine flameout actions).

3. If the decision to eject is made at high altitude, it is recommended that the pilot eject at a minimum of 10,000 feet AGL.

5.216 Ejection, using the ESCAPAC 1G-3 seat, may be accomplished on the ground, and within the flight envelope of the aircraft, except for abnormal flight conditions of steep angles of bank, inverted flight, and high rates of descent at very low altitudes. Minimum terrain clearance altitude for various attitudes are depicted in Figure 5-9. In dives steeper than 60 degrees, bank angle is negligible. The possibility of injury to shoulders and hips from flailing and wind blast damage to personal gear, and possible injury from parachute opening shock, makes it imperative that the airspeed be reduced to 350 KIAS or less prior to ejection. Inverted and severe yaw positions should be corrected, if feasible, prior to ejection.

WARNING

Certain combinations of angle of bank, airspeed, and dive angle will exceed the capabilities of the ESCAPAC 1G-3 seat. Refer Figure 5-9 to determine the terrain clearance required for safe ejection.

AL 7(0)

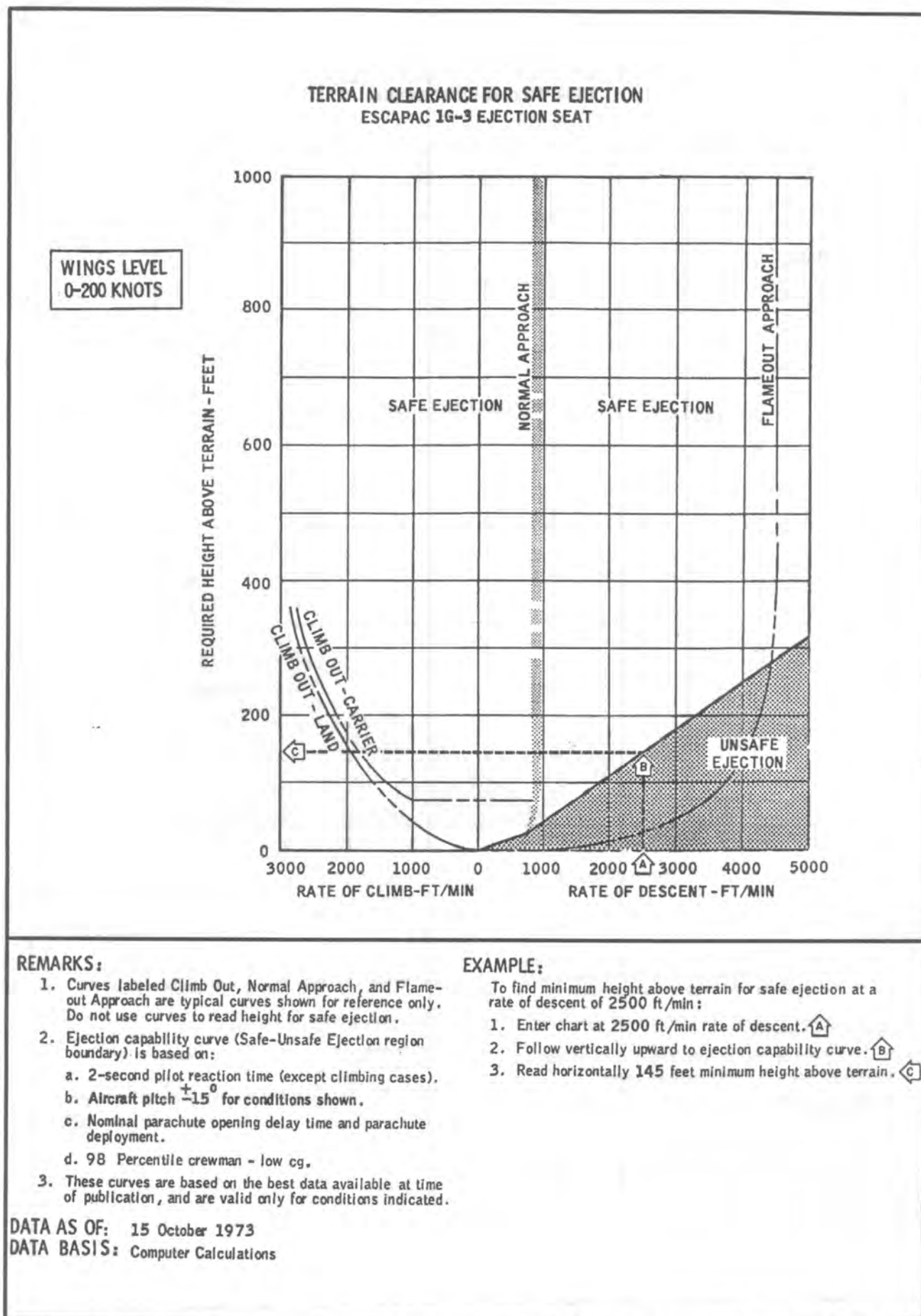
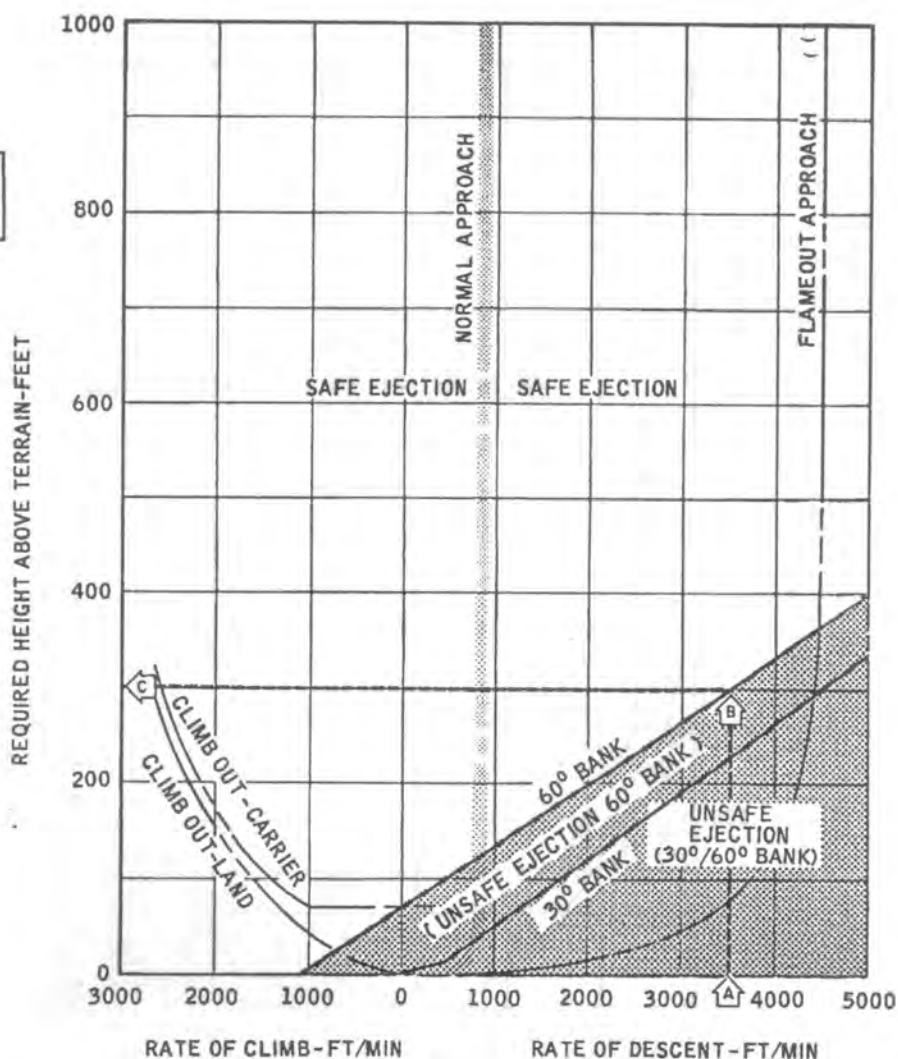


Figure 5-9 Terrain Clearance for Safe Ejection ESCAPAC 1G-3 Ejection Seat (Sheet 1 of 6)

TERRAIN CLEARANCE FOR SAFE EJECTION ESCAPAC 1G-3 EJECTION SEAT

30°-60° BANK
0-90 KNOTS



REMARKS

- 1 Curves labeled Climb Out, Normal Approach, and Flame-out Approach are typical curves shown for reference only. Do not use curves to read height for safe ejection.
- 2 Ejection capability curve (Safe-Unsafe Ejection region boundary) is based on:
 - a 2-second pilot reaction time (except climbing cases)
 - b Aircraft pitch $\pm 15^\circ$ for conditions shown
 - c Nominal parachute opening delay time and parachute deployment
 - d 98 percentile crewman - low cg
- 3 These curves are based on the best data available at time of publication, and are valid only for conditions indicated.

DATA AS OF 15 October 1973

DATA BASIS Computer Calculations

EXAMPLE

To find minimum height above terrain for safe ejection at a rate of descent of 3500 ft/min and a bank angle of 60°

- 1 Enter chart at 3500 ft/min rate of descent A
- 2 Follow vertically upward to ejection capability curve for 60° bank B
- 3 Read horizontally 300 feet minimum height above terrain C

Figure 5-9 Terrain Clearance for Safe Ejection ESCAPAC 1G-3 Ejection Seat (Sheet 2 of 6)

AL 7(0)

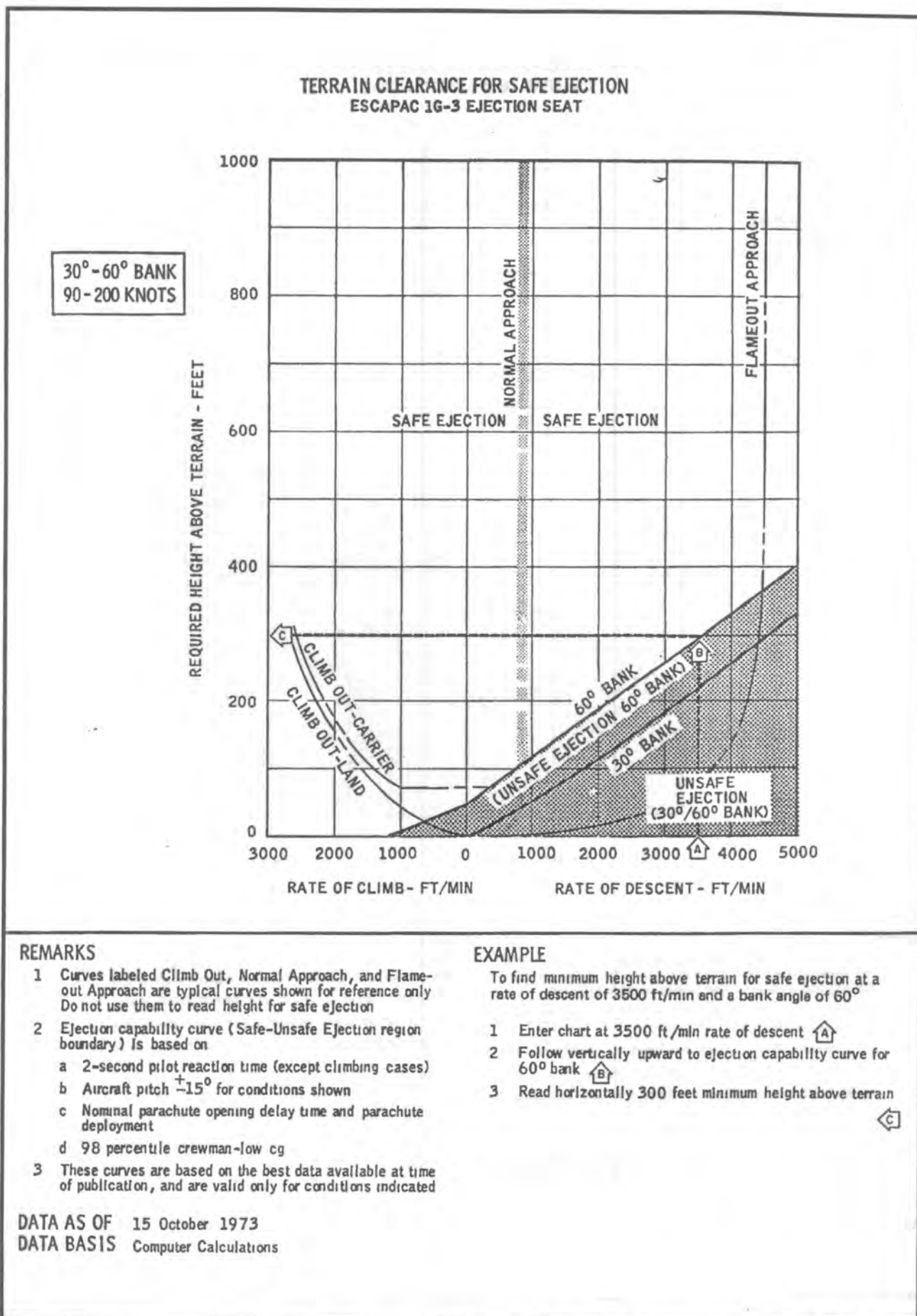
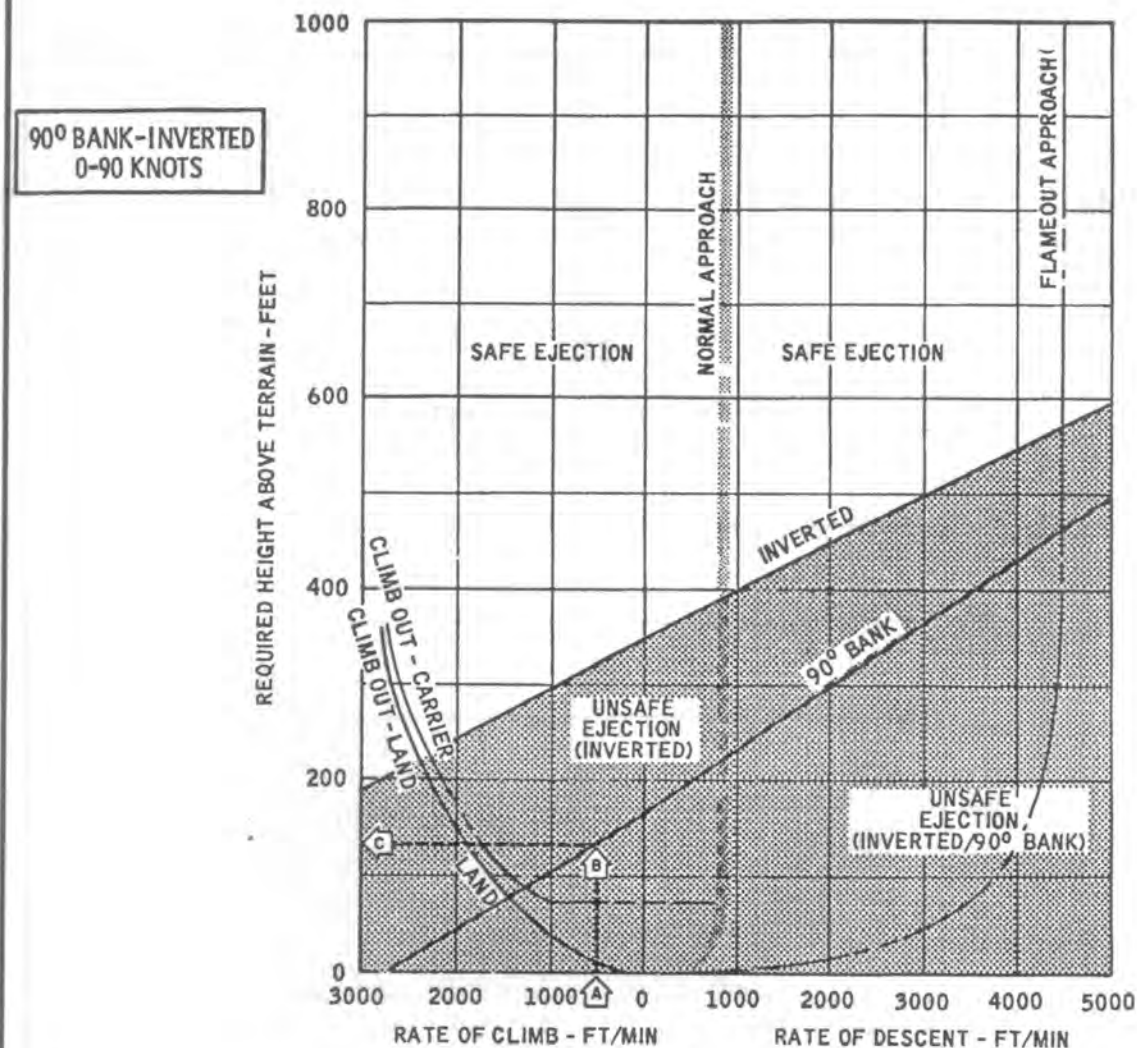


Figure 5-9 Terrain Clearance for Safe Ejection ESCAPAC 1G-3 Ejection Seat (Sheet 3 of 6)

AL 7(0)

TERRAIN CLEARANCE FOR SAFE EJECTION ESCAPAC 1G-3 EJECTION SEAT



REMARKS

- Curves labeled Climb Out, Normal Approach, and Flameout Approach are typical curves shown for reference only. Do not use curves to read height for safe ejection.
- Ejection capability curve (Safe-Unsafe Ejection region boundary) is based on:
 - 2-second pilot reaction time (except climbing cases)
 - Aircraft pitch $\pm 15^\circ$ for conditions shown
 - Nominal parachute opening delay time and parachute deployment
 - 98 percentile crewmen - high cg
- These curves are based on the best data available at time of publication, and are valid only for conditions indicated.

DATA AS OF 15 October 1973
 DATA BASIS Computer Calculations

EXAMPLE

To find minimum height above terrain for safe ejection at a rate of climb of 1500 ft/min and a bank angle of 90°

- Enter chart at 1500 ft/min rate of climb **A**
- Follow vertically upward to ejection capability curve **B**
- Read horizontally 130 feet minimum height above terrain **C**

Figure 5-9 Terrain Clearance for Safe Ejection ESCAPAC 1G-3 Ejection Seat (Sheet 4 of 6)

AL 7(0)

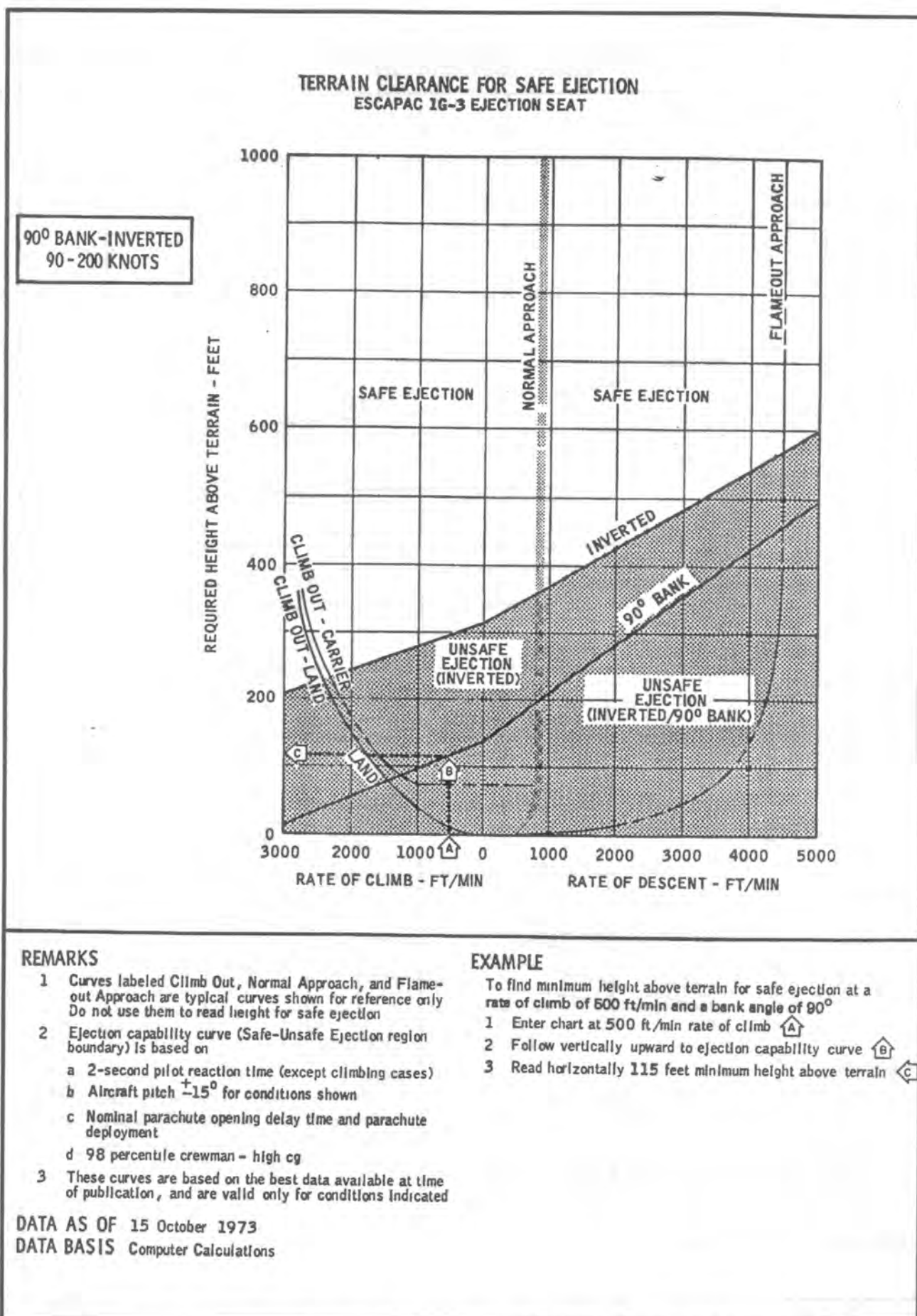
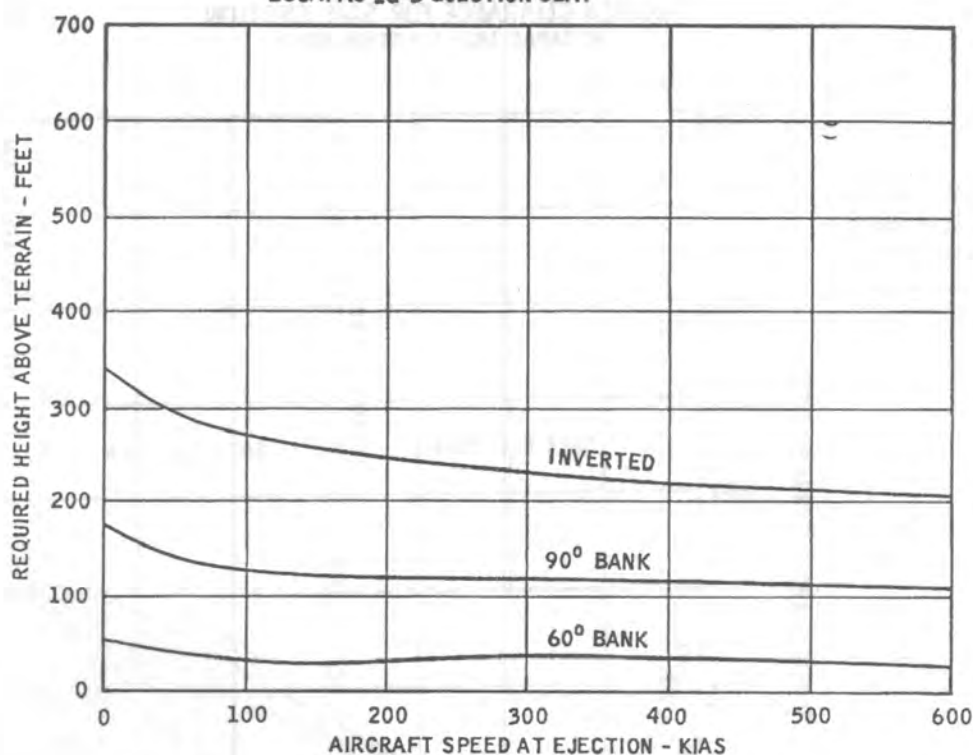


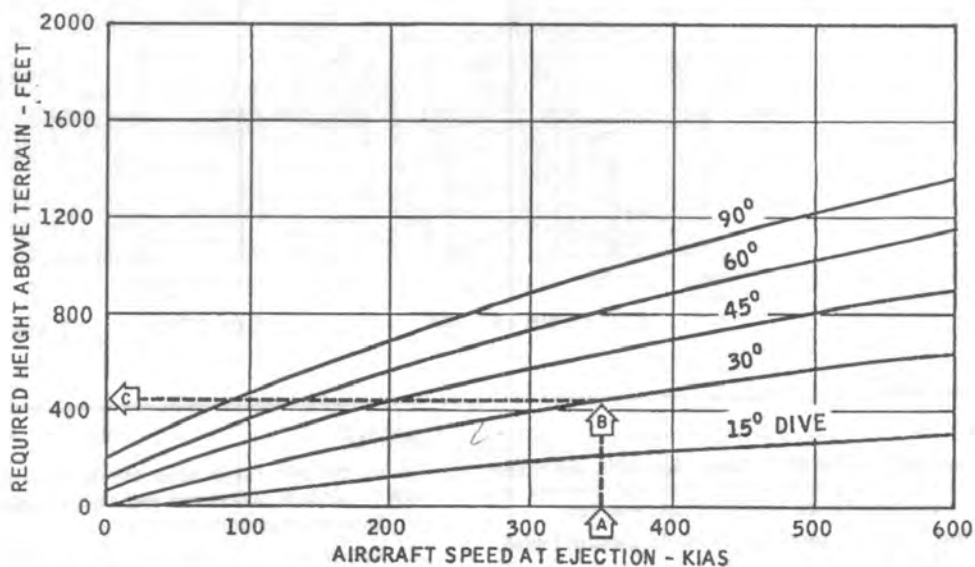
Figure 5-9 Terrain Clearance for Safe Ejection ESCAPAC 1G-3 Ejection Seat (Sheet 5 of 6)

AL 7(0)

TERRAIN CLEARANCE FOR SAFE EJECTION ESCAPAC 1G-3 EJECTION SEAT



DIVE- WINGS LEVEL



REMARKS

- 1 These curves do not include pilot's reaction time.
- 2 Ejection capability curve is based on 98 percentile crewman low cg except for the inverted case a high cg is used
- 3 These curves are based on the best data available at time of publication and are valid only for conditions indicated

EXAMPLE

- 1 Enter dive (wings level) chart at 350 KIAS
- 2 Follow vertically upward to 30° dive curve
- 3 Read horizontally 450 feet minimum height above terrain

DATA AS OF 15 October 1973
DATA BASIS Computer Calculations

Figure 5-9 Terrain Clearance for Safe Ejection ESCAPAC 1G-3 Ejection Seat (Sheet 6 of 6)

AL 7(0)

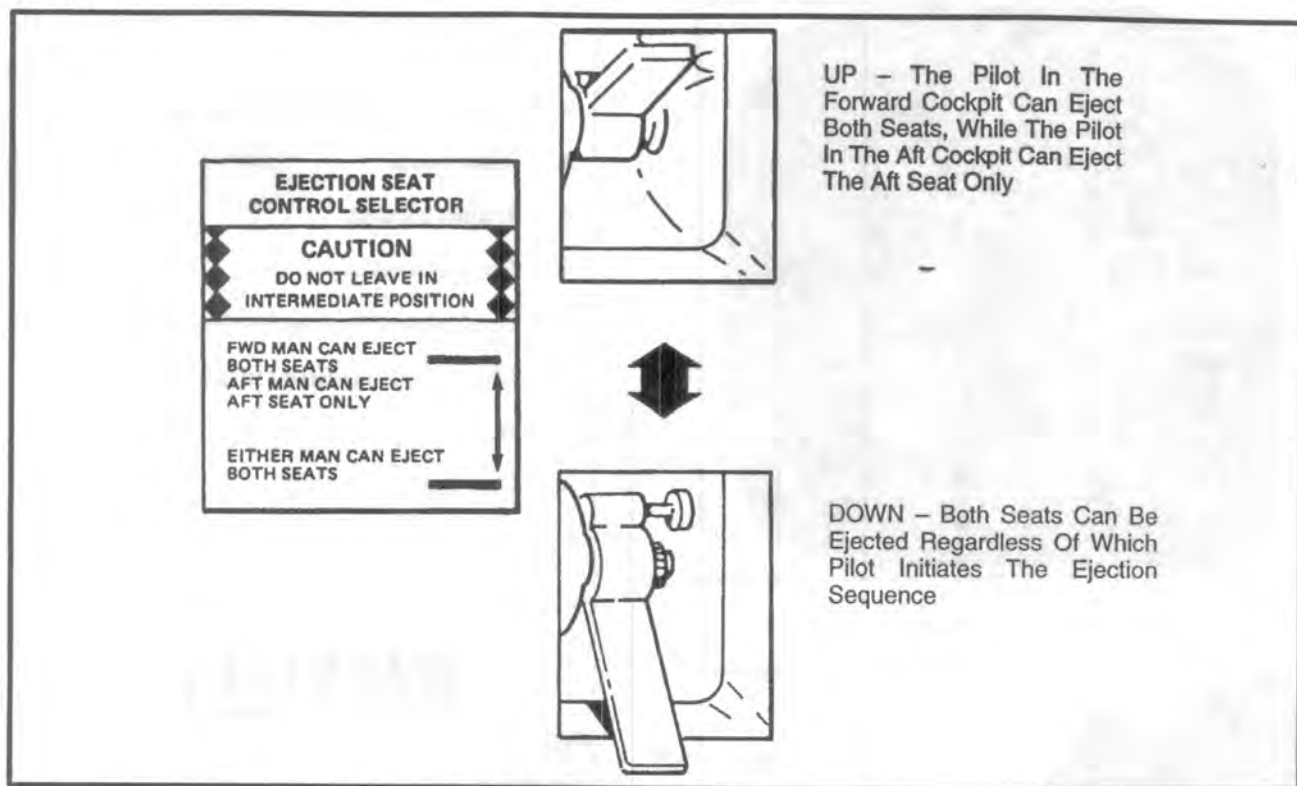


Figure 5-10 Ejection Seat Control Selector

TA-4 AIRCRAFT ONLY**Ejection Seat Control Selector**

5.217 The TA-4 has an Ejection Seat Control Selector fitted in the forward cockpit. It is located in the rear left hand side of the cockpit and should be checked and set during preflight. The two selector positions determine if the aft seat can eject both seats (down) or the aft seat only (up). The forward seat will always eject both seats, independent of selector position. Refer to Figure 5-10.

Command Ejection

5.218 When both seats in a TA-4 are occupied, certain emergency situations will result in a "command ejection". These situations should be briefed on the ground prior to takeoff. The pilot to be command ejected should immediately adopt the ejection body position in Figure 5-12, with the appropriate grip on the lower ejection handle.

EJECTION PREPARATION**Immediate Ejection**

5.219 Usually, the pilot will have time enough to accomplish several things to prepare himself for a successful ejection prior to pulling either handle. However, when the emergency condition requiring ejection is such

that ejection must be made without hesitation, simply grasp the lower ejection handle and pull forcefully to the fullest extent until seat ejects.

Controlled Ejection

5.220 Time permitting, complete the following:

1. Alert crew member.
2. Throttle IDLE
3. Reduce air speed to 350 KIAS or less.
4. Seat OPTIMUM POSITION
5. RAT AS REQUIRED
6. IFF EMERGENCY
7. Transmit MAYDAY position report.
8. Shoulder harness lock lever LOCKED
9. Visor DOWN
10. Air-conditioning switch RAM
11. Leave feet on rudder pedals.
12. Check altimeter.

WARNING

Do not shutdown engine. Unsuccessful seat activation may require continued flight to allow alternate egress method.

AL 7(0)



Figure 5-11 Check Altitude

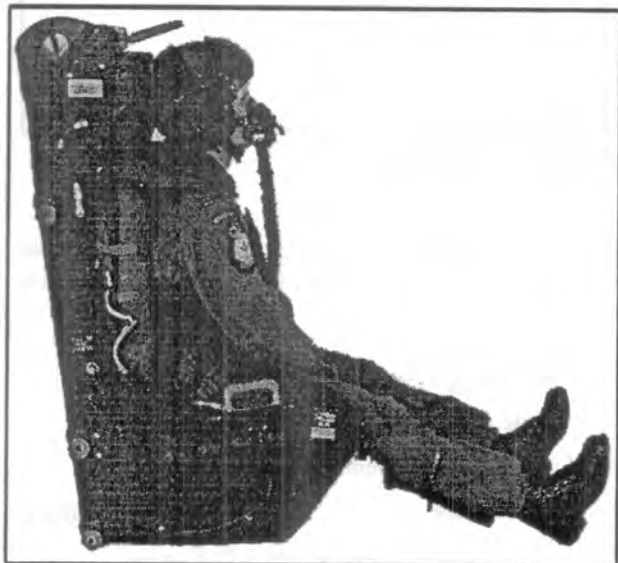


Figure 5-12 Ejection Body Position

13. Assume proper ejection body position in order to reduce the risk of injury. Refer Figure 5-13.
 - a. Lap and shoulder belts tightened.
 - b. Visor down
 - c. Helmet secured.
 - d. Oxygen mask tightened.
 - e. Head pressed back against headrest.
 - f. Chin slightly elevated (10 degrees up).
 - g. Back straight.
 - h. Hips against seat back.
 - i. Thighs flat on seat survival kit.
 - j. Feet on rudder pedals, heels on floor.

WARNING

Positioning the legs aft prior to ejection will cause the thighs to be raised off the seat thereby allowing the seat pan to gain significant speed before hitting the bottom of the thighs which could result in fractured femurs.

The legs must be kept apart to improve clearance from the HUD and to reduce the possibility of wind blast lifting the thighs over the side of the seat pan which could lead to a dislocated hip.

AL 7(0)

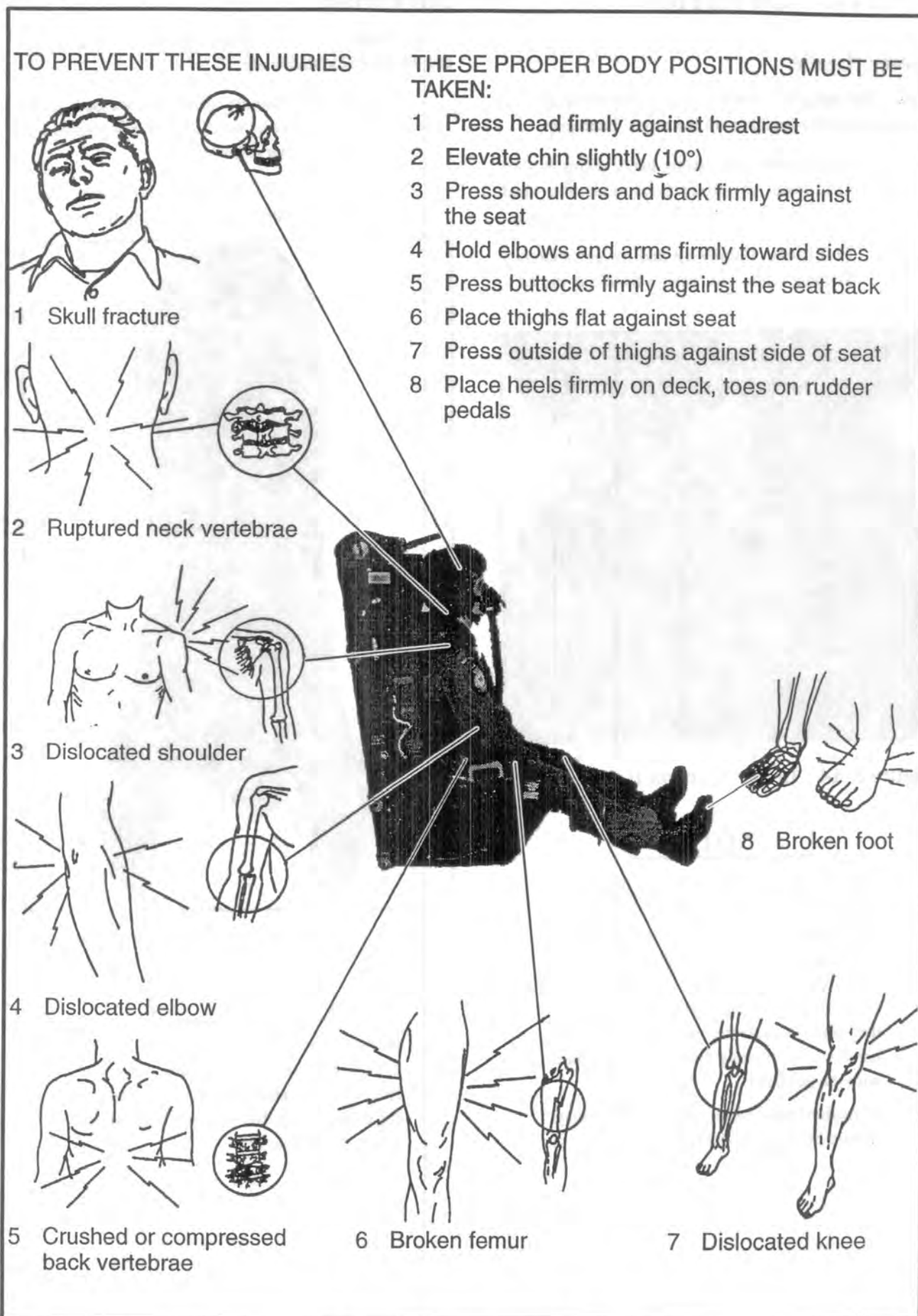


Figure 5-13 Ejection Injuries and Body Positioning

AL 7(0)

EJECTION INITIATION

Lower Handle

5.221 The recommended technique for ejection is using the lower ejection handle with the single-hand grip.

1. Grip handle with strong hand, palms inward. Grip wrist of strong hand with other hand, palms toward body and elbows close to body.
2. Pull handle sharply up and toward abdomen, keeping elbows in. Ensure handle is pulled to end of travel.

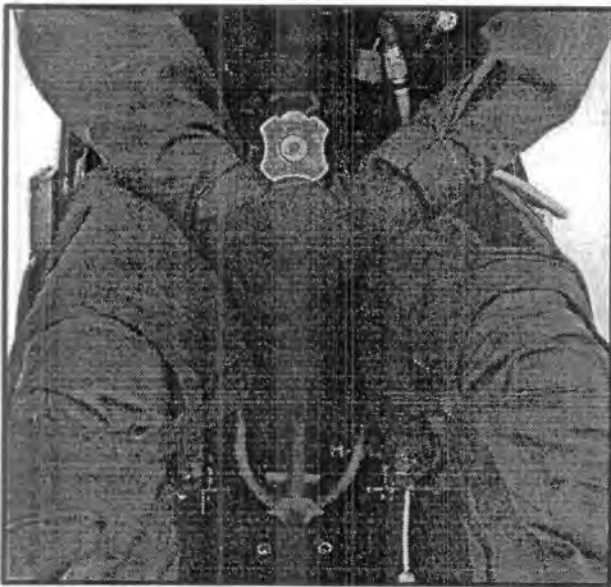


Figure 5-14 Lower Ejection Handle Grip

NOTE

During any combined low altitude/low airspeed conditions, as in the landing pattern or immediately after takeoff, the use of the lower ejection handle should be considered the primary means of ejection. If the situation precludes the use of the above grip then continue to fly the aircraft with the right hand, whilst initiating the ejection sequence with the left hand.

Actuation by the lower ejection handle may require between 85–100 pounds of pull.

Face Curtain

5.222 Should the seat fail to fire an alternative method is to use the Face Curtain handle.

1. Grip upper handle, palms toward body using "thumbs around handle" grip. Keep elbows as close together as possible.
2. Pull curtain sharply over head and into chest. Ensure handle is pulled to end of travel.

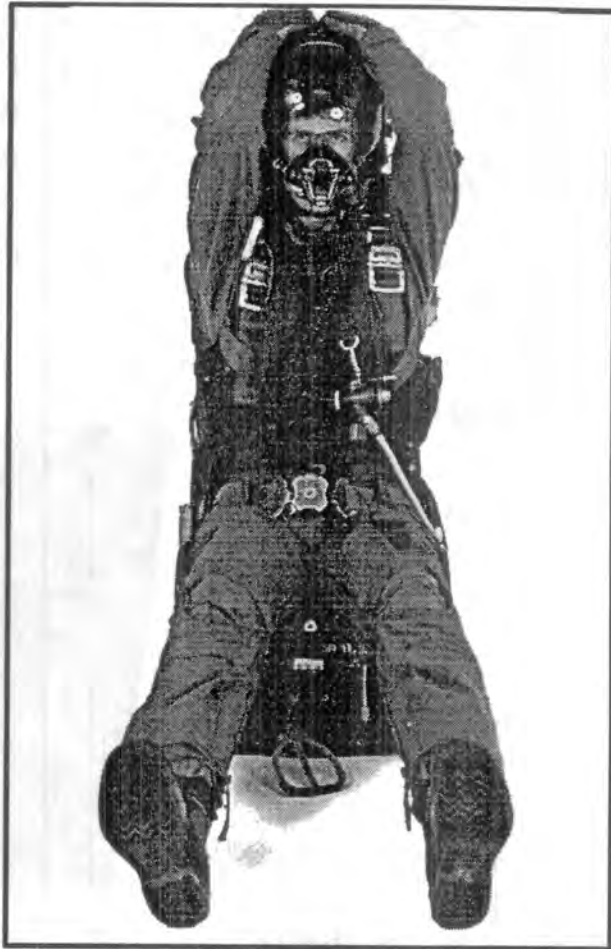


Figure 5-15 Face Curtain Handle Grip

NOTE

If either handle is pulled extremely quickly, the canopy interlock may cause a pause or stop in the movement of the handle. The pull force should not be relaxed. Continue the pull to fire the seat.

AL 7(0)

Canopy Fails To Jettison

5.223 If pulling the lower ejection handle (or face curtain) fails to jettison the canopy, substitute the following emergency procedures:

1. Retain a firm grip on lower ejection handle (or face curtain) with one hand, but do not pull it farther out. Hold elbows inboard.
2. Pull canopy-jettison handle firmly.
3. After the canopy leaves, continue pulling lower ejection handle (or face curtain) with both hands.
4. If the canopy still remains, as a last resort it may be removed by the force of the airstream by moving and holding canopy control handle in the OPEN position if airspeed is above 120 KIAS. If canopy control handle is placed in the UNLOCKED position (not held in OPEN position), airspeed must be at least 240 KIAS. Retain lower ejection handle (or face curtain) with one hand during this procedure.

EJECTION SEQUENCE

5.224 After lower handle (face curtain) is pulled:

1. Canopy jettisons.

2. The power retract mechanism on the inertia reel in both cockpits activates, pulling the occupant to proper sitting position for ejection.
3. In the TA-4 the seats eject individually, with the aft seat ejecting 0.57 seconds before the forward seat to prevent blast injury.
4. During ejection the automatic actuation lanyard for the emergency oxygen system activates the reducer assembly. The pilot is then supplied emergency oxygen for descent. The AN/URT-33 radio beacon is also actuated by means of a lanyard upon seat ejection. The beacon will provide a continuous signal until manually switched off.

WARNING

Do not use four line release if any of the shroud lines are severed or looped over the canopy, or any damage to the parachute is evident.

NOTE

For details of ejection seat mechanical operation, see Chapter 1.

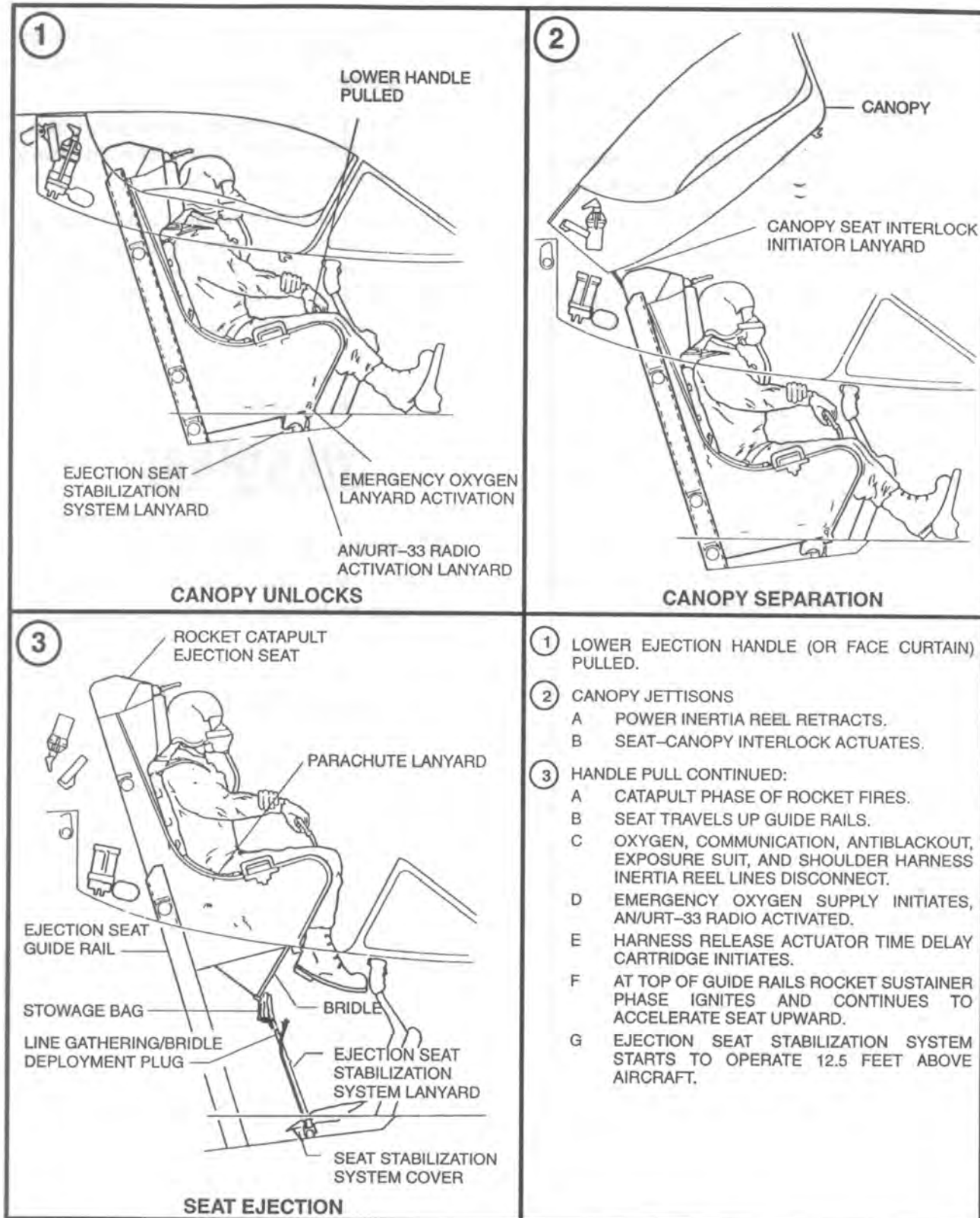


Figure 5-16 Ejection Sequence ESCAPAC 1G-3 Ejection Seat (Sheet 1 of 2)

AL 7(0)

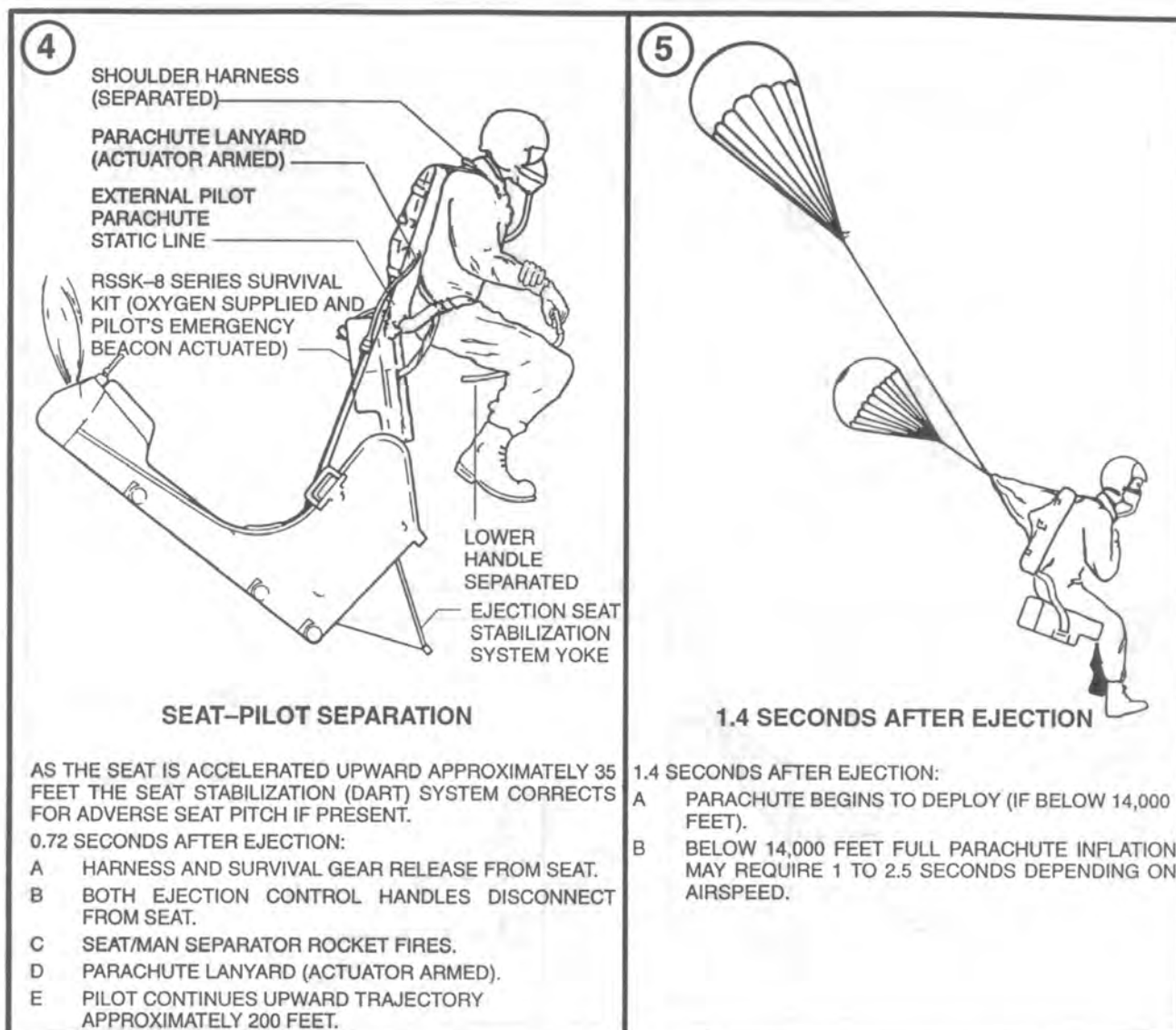


Figure 5-16 Ejection Sequence ESCAPAC 1G-3 Ejection Seat (Sheet 2 of 2)

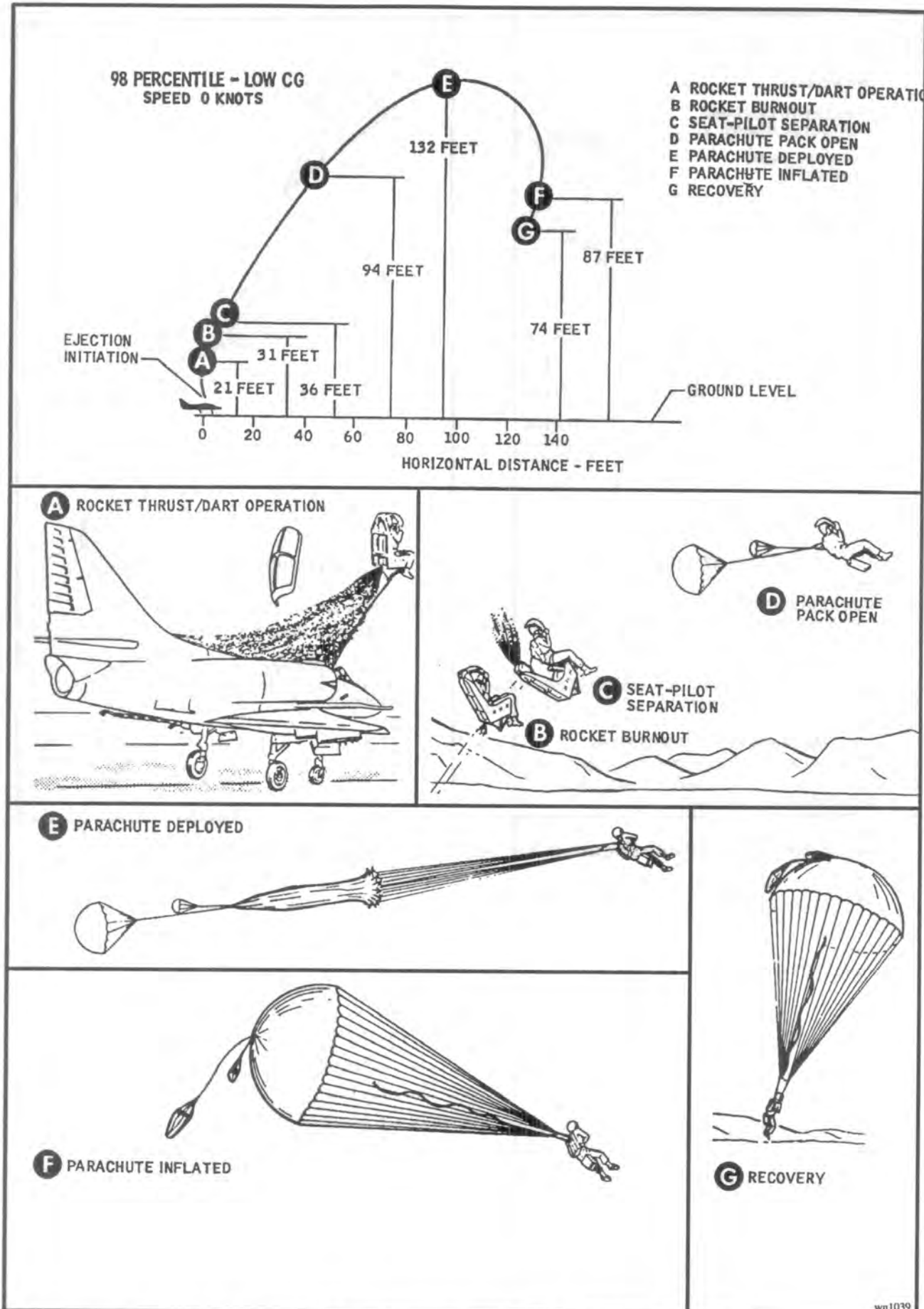


Figure 5-17 Ground Level Ejection - ESCAPAC 1G-3 Ejection Seat

AL 7(0)

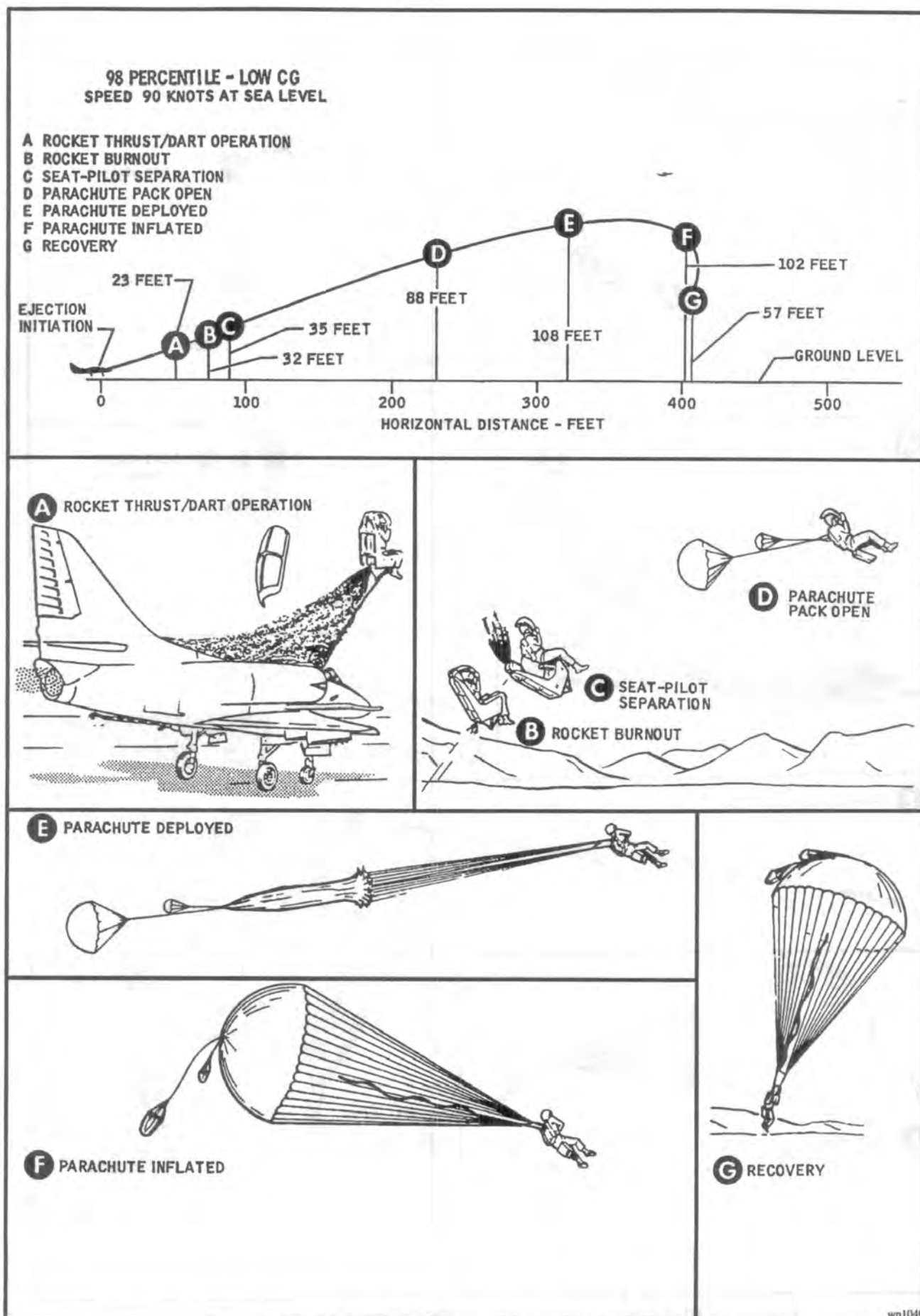


Figure 5-18 Low Speed Ejection - ESCAPAC 1G-3 Ejection Seat

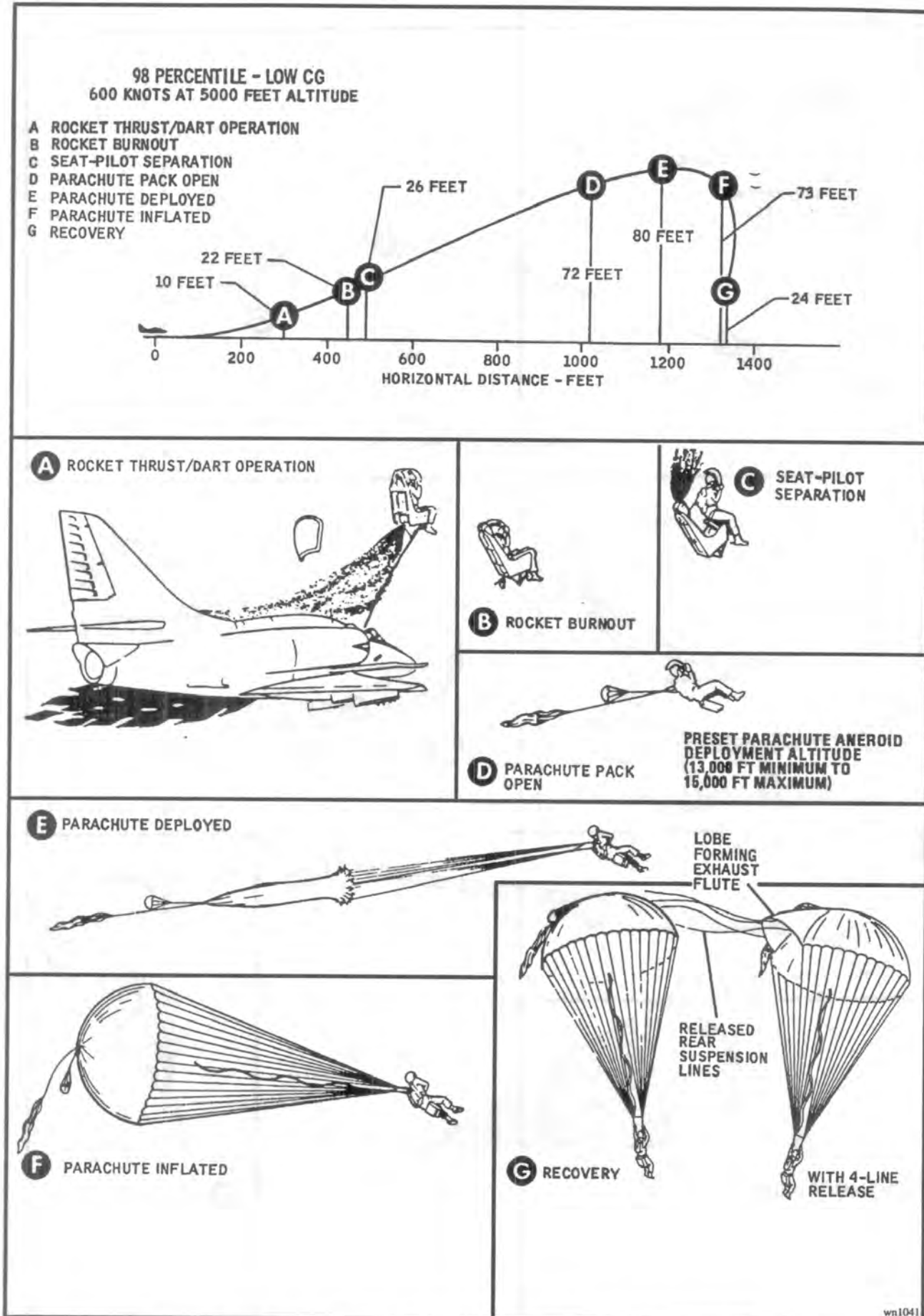


Figure 5-19 High Speed Ejection – ESCAPAC 1G Ejection Seat

AL 7(0)

AUTOMATIC SEAT/PILOT SEPARATION

5.225 The ejection seat automatically provides positive seat separation by means of a seat/man separator rocket. The thrust of the rocket simultaneously separates and propels the seat away from the pilot, minimizing the probability of collision between the seat and the pilot or his parachute after seat/man separation.

5.226 A separator rocket is fired 0.52 second after start of the initial ejection sequence, forcibly separating the pilot from the seat. The barometric time-delay parachute actuator is armed when the pilot separates from the seat. This causes the ripcord pins to be pulled 0.75 second after seat/pilot separation, resulting in a fully inflated parachute, if below $14,000 \pm 500$ feet. If above barometric opening altitude, the pilot must free-fall, less the seat, to the barometric opening altitude before automatic parachute deployment will occur. If ejection occurs below the preset altitude and the automatic barometric ripcord actuator seems not to function, open the parachute with the parachute ripcord when clear of the seat. The parachute ripcord overrides the barometric release. If high-altitude ejection is made, free-fall to approximately 14,000 feet before opening the parachute. If the parachute must be opened manually after a high-speed ejection, wait at least 4 seconds after ejection to permit speed to reduce.

WARNING

During the ejection, if either the harness release or automatic barometric parachute actuator cartridge fails to function properly, automatic seat separation and/or parachute deployment may not occur. Therefore, during any low-altitude ejection, the pilot should attempt to "beat the seat" by manually pulling the manual seat separation handle and then the parachute ripcord immediately after ejection.

5.227 If after ejection from the aircraft, automatic seat/pilot separation has not occurred, manual seat/pilot separation procedures must be performed.

MANUAL SEAT/PILOT SEPARATION

5.228 Perform the following procedures to effect seat/pilot separation:



Figure 5-20 Squeeze Manual Seat Separation Handle Trigger

1. Locate Manual Seat Separation handle on right side of ejection seat. Squeeze handle trigger.



Figure 5-21 Operate Emergency Restraint Release

2. Operate Emergency Restraint Release by pulling manual seat separation handle straight up.

WARNING

Automatic chute deployment will not occur if the pilot manually separates from the seat. The parachute ripcord must be pulled.

AL 7(0)



Figure 5-22 Push Seat Away

3. Lean forward to clear the parachute from back of seat and push clear of seat.



Figure 5-23 Locate And Operate Ripcord

4. Locate Ripcord handle on left hand shoulder.
5. With your right hand — Grip parachute ripcord handle and pull downward to right side of body.
6. Once canopy has opened continue with appropriate drills.

MANUAL BAILOUT

5.229 Even under the most favourable circumstances (level flight, slow air speeds, and optimum altitude), manual bailout from high performance aircraft is extremely hazardous and is considered a last resort method of escape. However, if the seat cannot be ejected and ditching is not feasible, the following bailout procedures are suggested:

WARNING

If over 14,000 ± 500 feet and bailout is required, freefall to below 14,000 feet since parachute opening shock increases with altitude. As a rule of thumb, 5 seconds are required to freefall 1000 feet.

Manual bailout is not recommended below 2000 feet.

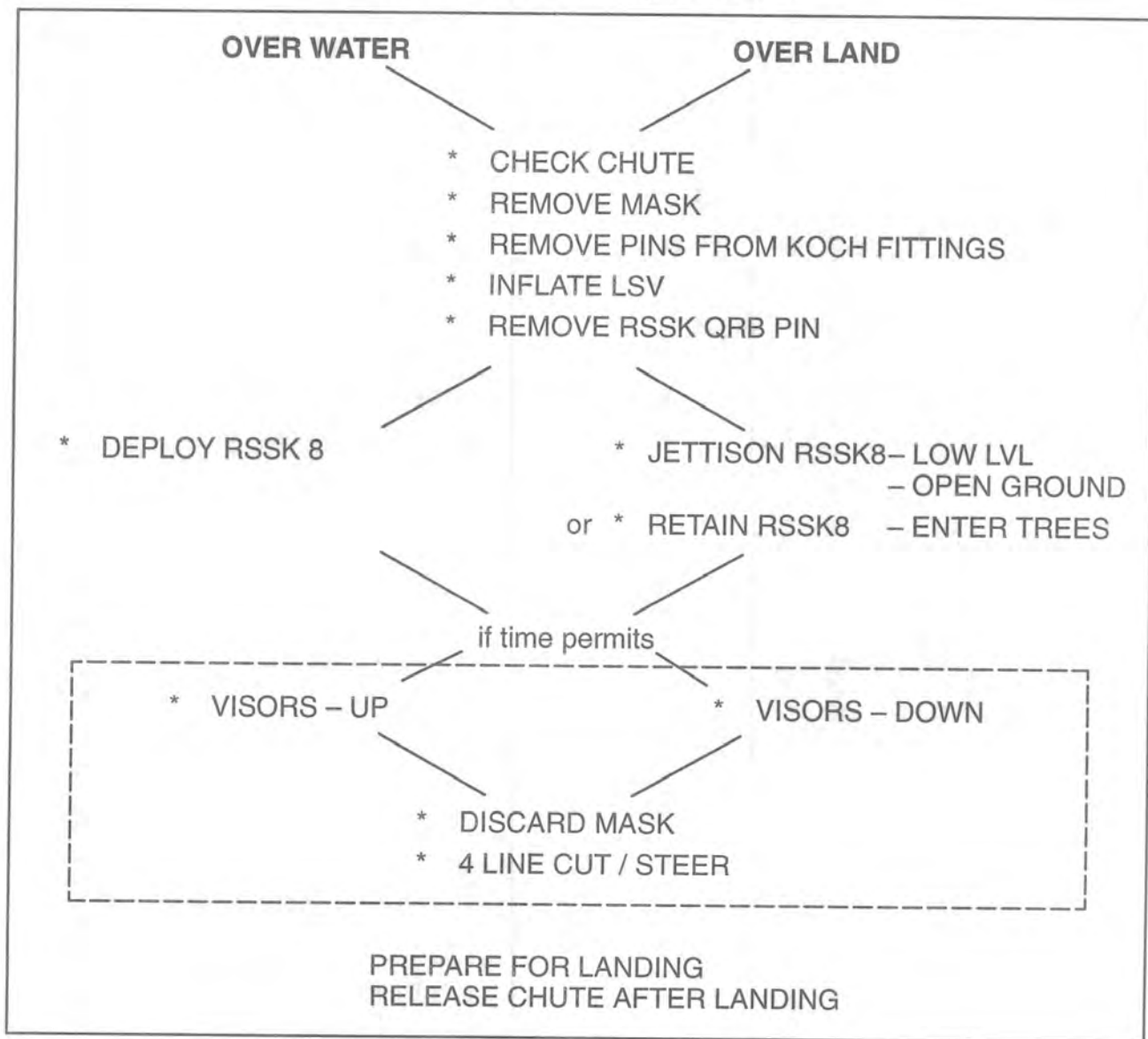
1. Pull green ring on seat pan for emergency oxygen.
2. Disconnect console oxygen and anti-blackout hose.
3. Select RAM air.
4. Jettison canopy.
5. Pull emergency restraint release handle.
6. Lean forward to clear parachute past headrest.
7. Trim aircraft nose down.
8. Apply back pressure to stick.
9. Position arms against body and let stick snap forward.
10. When clear of aircraft and below approximately 14 000 feet, pull parachute ripcord.
11. As time permits perform post-ejection procedures.

POST-EJECTION PROCEDURES

5.230 Post-ejection procedures are detailed in Table 5-15.

AL 7(0)

Table 5-15 Summary Of Actions



AL 13(7)

5.231 Immediately following opening shock, check condition of parachute.



Figure 5-24 Check Parachute

5.232 If there is no chute damage/malfunction, proceed as follows:

1. *Post NZM/222.005/22 and NZM/222.015/8.* Remove mask by pressing spring loaded receiver on the right hand side of the helmet.



Figure 5-25 Remove Mask

2. *Pre NZM/222.005/22 and NZM/222.015/8.* Remove mask, and unhook right mask chain.
3. Remove Shoulder Harness Safety Pins, from koch fittings.



Figure 5-26 Remove Koch Fitting Pins

4. Locate beaded handle on LSV left hand side.
5. Pull beaded handle down and straight out to inflate. If LSV fails to inflate, use oral inflation tube.
6. Remove RSSK8 QRB Pin (Refer Figure 5-26a)

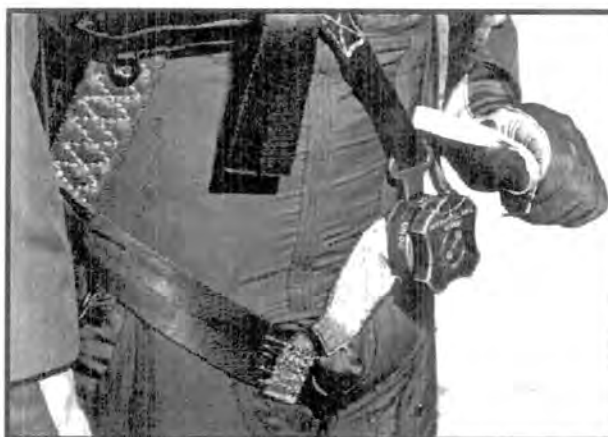


Figure 5-27 Remove RSSK8 QRB Pin

7. Deploy the RSSK8 survival kit. With right hand, locate kit release handle and kit strap release handle on right side of seat kit.
8. Pull upwards on kit strap release handle with forefinger of right hand, while at the same time, pulling upward on seat kit release handle with the other three fingers.

AL 13(7)



Figure 5-28 Inflate LSV



Figure 5-29 Deploy RSSK8 Survival Kit

WARNING

Unless survival kit strap release handle is pulled simultaneously with or before seat kit release handle, the survival kit will not deploy beneath the pilot during descent, resulting in a hazardous landing.

Deploying the survival seat kit is not recommended over land.

OPTIONS

5.233 If time and altitude permit the following options for the visor, oxygen mask, and parachute four-line release may be considered:

1. Raise visor.

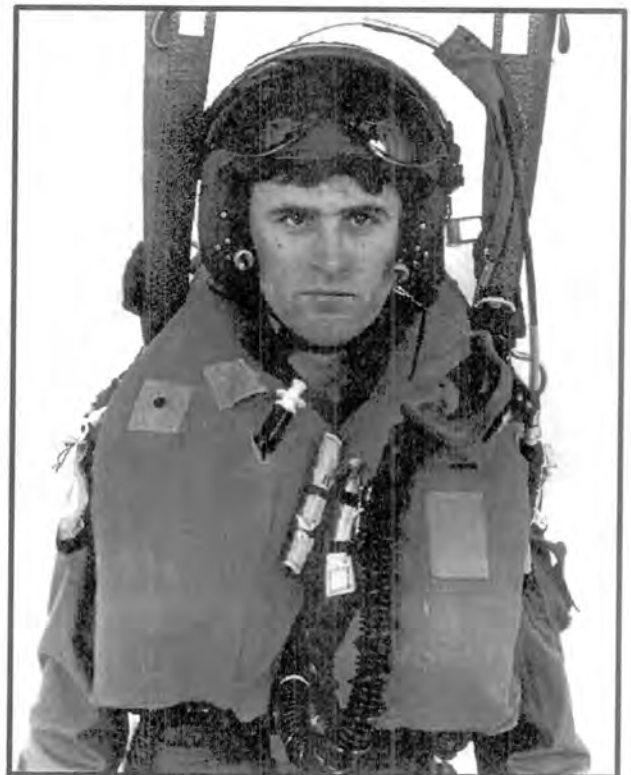


Figure 5-30 Raise Visor

2. *Post NZM/222.005/22 and NZM/222.015/8.* Press left hand helmet receiver.
3. *Pre NZM/222.005/22 and NZM/222.015/8.* Disconnect left hand chain.
4. Disconnect Emergency Oxygen hose.
5. Disconnect Oxygen Mask clip.

AL 13(7)



Figure 5-31 Discard Oxygen Mask

6. Discard Oxygen Mask.
7. Locate the parachute control lanyards on inside of rear risers and pull down sharply.



Figure 5-32 Operate 4 Line Release Handles

WARNING

Do not use four line release if any of the shroud lines are severed or looped over the canopy, or any damage to the parachute is evident.

NOTE

Four suspension lines release from their connector links and a lobe forms at the centre rear of the parachute creating a controlled channel for air escape, and generating approximately 5 knots forward speed.



Figure 5-33 Turn Into Wind

8. Pull down on lanyard in the direction you wish to turn.

NOTE

In case of an injured arm, it is safe to activate only one side of the four-line release system. The parachute will turn into the direction of the side activated.

A 180-degree turn can be accomplished in about 20 seconds.

AL 7(6)

LANDING PREPARATION OVER WATER

5.234 Try to determine the wind direction at the surface using white caps, smoke from wreckage, or known surface winds in the vicinity. When nearing the surface, manoeuvre the parachute so that you are facing into the wind, then assume the proper body position for landing.

- a. Feet together.
- b. Knees slightly bent.
- c. Toes pointed slightly downward.
- d. Eyes on the horizon.
- e. Firmly grasp parachute release fittings.
- f. Tuck elbows in prior to water entry.

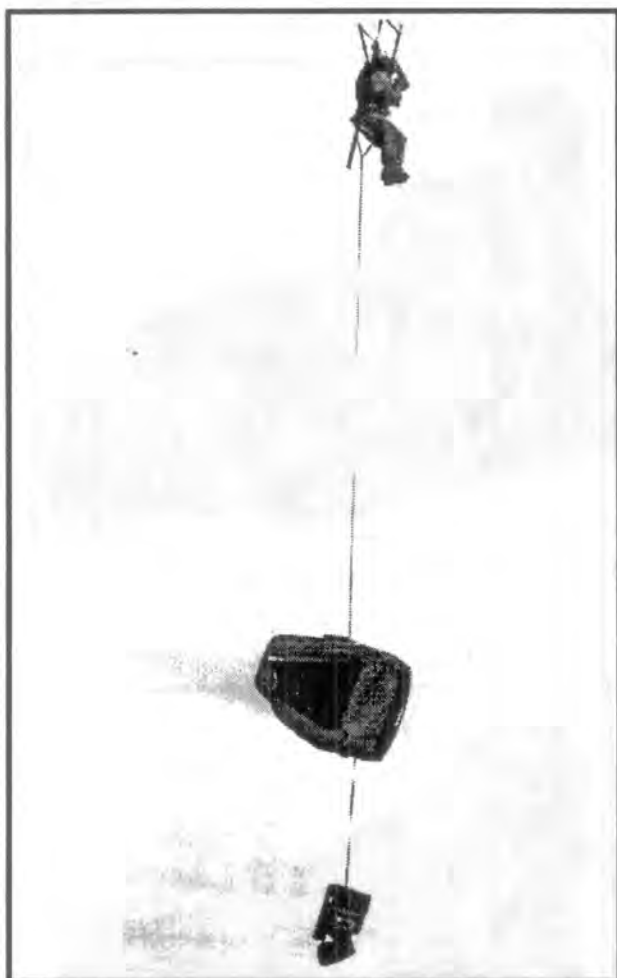


Figure 5-34 Preparation For Water Entry

Parachute Release Procedure

5.235 As feet touch the water, push up on quick release locking lever then pull down to release parachute.

WARNING

Do not disconnect quick-release Koch fittings until after contact with ground or water.

Ejection at low altitude allows only a matter of seconds to prepare for landing. The variety and complexity of conditions encountered during the "time critical" period following a low altitude over water ejection make it impossible to formulate procedures to cover every contingency.

Over water, inflation of the LSV is the most important step to be accomplished. Release of the parachute quick-release Koch fittings as the feet contact the water is the second most important step to prevent entanglement in the parachute shroud lines.

The survivor must be prepared to cut shroud lines that are dragging him down.



Figure 5-35 Release Parachute On Entering Water

AL 7(0)

RAFT BOARDING

5.236 When clear of parachute canopy, retrieve life raft by locating dropline and pulling raft to you.

1. Attach retaining lanyard to the dinghy handle.



Figure 5-36 Attach Lanyard To Raft

2. Locate quick-release fitting and release upper half of survival kit. Ensure EMERG OXY Hose is disconnected from the mask.



Figure 5-37 Release Seat Kit

3. Bring raft around for entry into smaller end (stern).

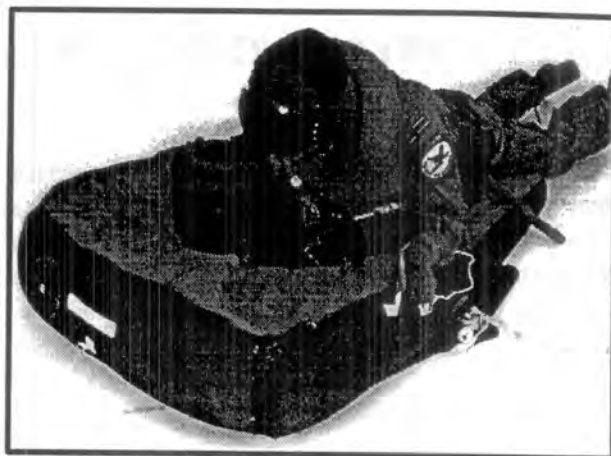


Figure 5-38 Board Raft

WARNING

Ensure that no sharp edges contact the life raft.

4. Using boarding handles, pull into raft and turn toward a seated position.



Figure 5-39 Sitting Position In Raft

5. Move into a comfortable and well balanced position.



Figure 5-40 Retrieve Survival Pack

AL 13(7)

6. Retrieve lower half of Seat Kit.
7. Locate and retrieve AN/URT-33 and survival equipment from lower portion of seat kit.

WARNING

The URT-33 is not tied and once removed from seat pan, care must be taken to prevent its loss.



Figure 5-41 Retrieve URT-33

8. Bail and sponge out the water in the raft.
9. Inflate the floor and canopy.



Figure 5-42 Canopy Inflation

SIGNALLING DEVICES

5.237 The following information describes the use of signalling devices while in the life raft and is not intended to prescribe any given order of priority which would be dictated by the immediate situation of the survivor.

Signal Distress Kit

5.238 Screw cartridge flare into launcher while keeping flare pointed in a safe direction.

5.239 Hold launcher directly overhead. Pull back on trigger and release. The flare has a minimum 4 1/2 second duration and can be launched to about 200 feet.

WARNING

Prior to securing cartridge into pencil-type launcher, ensure launcher is not in cocked position prior to inserting a cartridge flare.



Figure 5-43 Signal Distress Kit



Figure 5-44 Hold Well Clear When Firing

AL 8(7)

SDU-5/E Distress Marker Light

5.240 SDU-5/E Distress Marker Light can be attached to the helmet by mating hook and pile (velcro) tape. This frees the hands for using other signalling devices while allowing light to flash up into the sky and reflect off the helmet.

NOTE

SDU-5/E is actuated by pressing button on bottom of light, and emits 360° beam of light which flashes at a rate of 40–60 flashes per minute for approximately 12 hours.



Figure 5-45 Distress Marker Light
Emergency Signalling Mirror

5.241 Procedure.

1. Place lanyard over head and around neck.
2. Reflect sunlight onto nearby surface (raft, hand, etc).
3. Slowly bring mirror up to eye level and look through sighting hole. You will see a bright spot: the aim indicator.
4. Hold mirror close to eye, slowly turn and manipulate so that bright light is on target.
5. Even if there are no aircraft or ships in sight, continue to sweep horizon. Mirror flashes can be seen for many miles, even in hazy weather.

NOTE

Mirror flashes reflect light with a brilliance of up to 8 million candle power, and with a range of 45–50 miles with search aircraft at 5000 feet on a clear day.



Figure 5-46 Use Of Emergency Signalling Mirror

No 1 Mk 2 Signal Distress Day and Night

5.242 The No 1 Mk 2 Signal Distress Day and Night is used to attract attention of SAR aircraft and to give wind direction.

WARNING

No 1 Mk 2 signals may reach a temperature that is uncomfortable to handle after ignition. Use of gloves is recommended. Cool expended end of No1 Mk 2 signal by dousing in water.

NOTE

The illumination flare end has eight castellated protrusions on the cap. The smoke end has a smooth cap. The flare burns for approximately 20 seconds.



Figure 5-47 Smoke and Illumination Signal

AL 11(7)



Figure 5-48 AN/URT-33A Beacon

AN/URT-33A Radio Beacon Set

5.243 The AN/URT-33 radio automatically transmits a swept tone signal on 243.0 MHz when the ejection seat leaves the floor of the aircraft.

NOTE

The AN/URT-33 must be turned off when using the Becker MR509 PLB on 243.0 MHz to prevent interference. When word "on" is visible, the radio is on.

Do not point antenna directly at receiving aircraft, as this reduces the likelihood of reception.

Becker MR509 Personal Locator Beacon

5.244 The personal locator beacon (PLB) transmits simultaneously (intermittent) in the beacon mode on the 121.5 MHz and 243.0 MHz international emergency frequencies and also alternately on the 406.025 MHz international satellite emergency frequency. In voice communication mode the PLB operates exclusively on 243.0 MHz UHF frequency. Refer Figure 5-49 for the location of controls and indicators and Table 5-16 for their description and functions.

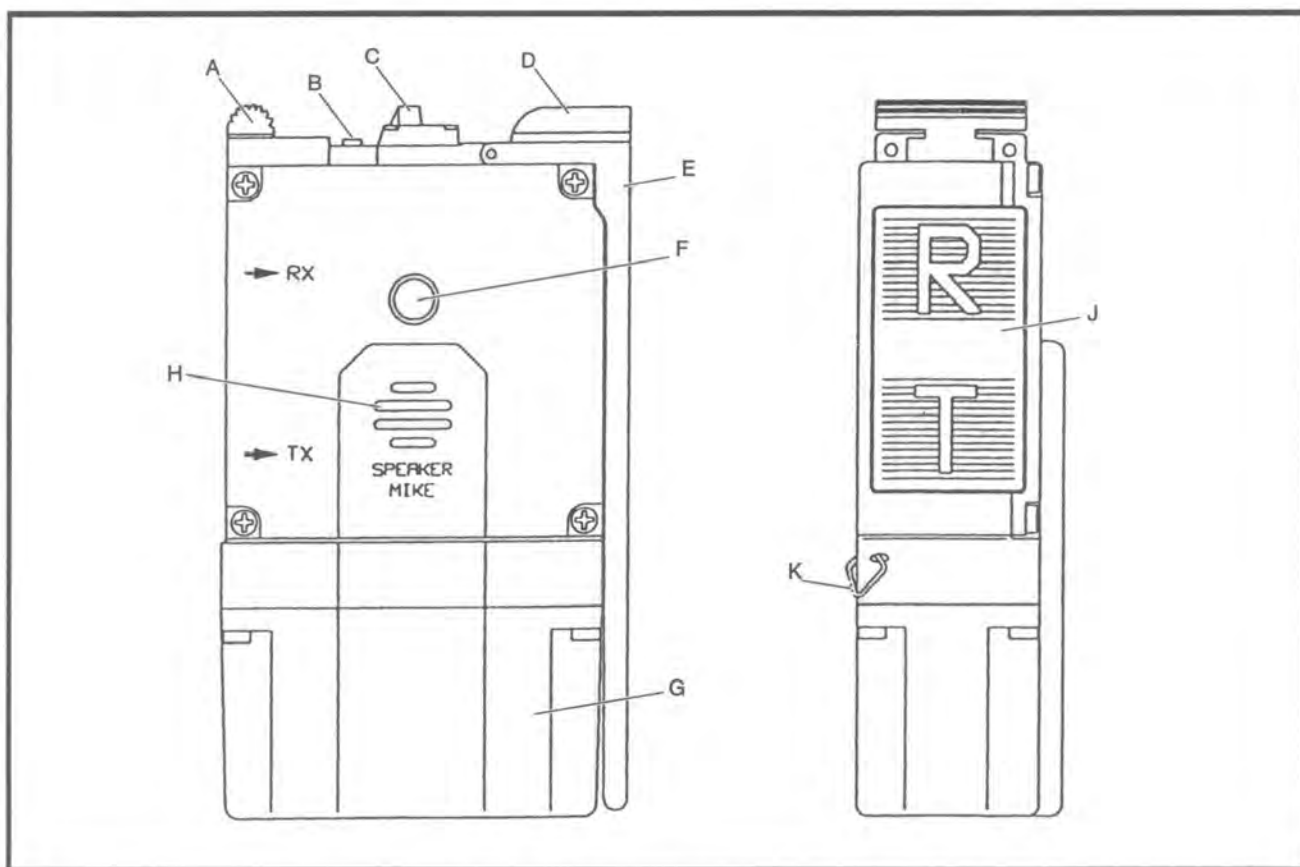


Figure 5-49 MR509 PLB – Controls and Indicators

AL 11(7)

CAUTION

The AN/URT-33 must be turned off when using the PLB for voice communication to prevent interference.

Activation Sequence

5.245 The PLB is activated by the following sequence:

1. During the inflation of the life preserver, the antenna aligns itself vertical to the life preserver lobe.
2. Pull the toggle at the lower end of the PLB pocket, located on the front left-hand side of the life preserver.

3. The PLB is now activated and operates automatically on 121.5, 243.0 and 406.025 MHz in the beacon emergency mode.

Survivor Confidence Check

5.246 Carrying out the following procedures to check and monitor PLB emergency signals:

1. Open the PLB pocket by separating the velcroed top flap and covering flaps.
2. Pull down on the webbing retention harness and remove the PLB with connected antenna. The PLB is tethered to the life preserver for security.
3. Hold the PLB in front of the face to monitor the transmitted emergency signals via the yellow flashing LED indicator. Listen for the transmitted modulation from the speaker/microphone.

Table 5-16 MR509 PLB – Description and Function of Controls and Indicators

Letter	Control and Indicator	Description	Function
A	On/Off Switch	Two-position slide switch.	On/off switch of personal locator beacon (if no activating magnet is used).
B	Antenna Socket	Coaxial socket.	Connecting the equipment antenna or life jacket antenna.
C	Activating Magnet Holder	Mechanical device.	Holding the activating magnet.
D	Handle	Yellow handle which can be rotated through 360 degrees (with two detent positions).	Locking the equipment antenna to the sidewall of the unit.
E	Equipment Antenna	Multi-range antenna, single part.	Transmitting/receiving antenna which also allows the personal locator beacon to be fixed on the life jacket.
F	Visual Indicator	LED, yellow.	Flashes in beacon mode in rhythm with the modulation. Comes on during BITE if there is a positive result and flashes if there is a fault in the unit.
G	Battery Housing	Mounting for battery.	Protects the equipment battery.
H	Speaker / Microphone	Dynamic 40 ohm microphone.	Used in beacon mode and reception mode as a speaker and in the transmission mode as a microphone.
J	Mode Switch R/T (Receive / Transmit)	A rocker switch with two momentary key positions and one stable rest position.	Changeover from transmission to reception and vice versa in voice communication mode. Position R is used in conjunction with the BITE and position T in conjunction with the equipment test.
K	Eye for Tether	Metal eye.	Securing tether to the personal locator beacon.

AL 11(7)

Voice Communication

5.247 To achieve voice communication proceed as follows:

1. With the PLB held in front of the face activate the mode switch on the left-hand side of the PLB.
2. When button T (transmit) of the mode switch is pressed, the beacon mode is interrupted and a changeover to transmission takes place for as long as the button is depressed. During transmission, speak loudly into the microphone with the lips almost touching the microphone. When button T is released, the PLB automatically reverts to the beacon emergency mode.
3. When button R (receive) of the mode switch is pressed, the beacon emergency mode is also interrupted and a changeover to reception takes place for as long as the button is depressed. The reception signal is monitored via the speaker. When button R is released, the PLB automatically reverts to the beacon emergency mode.

Externally Activated Voice Communication

5.248 PLB reception can be initiated automatically by the following means:

1. The PLB will automatically receive an audio pilot tone from a searching aircraft of 1 kHz. It will automatically switch into receive mode, and remain on for 15 – 20 seconds allowing time for the distressed PLB operator to respond with voice communication.
2. If the PLB operator presses button T of the mode switch during the 15 – 20 seconds in order to answer, the PLB will operate in the normal voice communication mode. If button T is not operated within this time, the PLB will automatically return to the beacon emergency mode.

Operation with Integral Antenna

5.249 To operate the PLB with the integral antenna proceed as follows (refer Figure 5-50):

1. Remove the top plastic guiding hood and disconnect the life preserver antenna cable.
2. Turn the yellow knob on top of the PLB through 180 degrees.
3. Erect and lock the integral antenna.

4. Move the slide bar on top of the PLB to the ON position.
5. The PLB is now activated and operates automatically in the beacon mode, transmitting emergency signals.
6. Voice communication is achieved by activating the mode switch on the side of the PLB. Press button T to transmit and button R to receive, on the mode switch. During transmission, speak loudly into the microphone with the lips almost touching the microphone.

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5.251 Deleted.

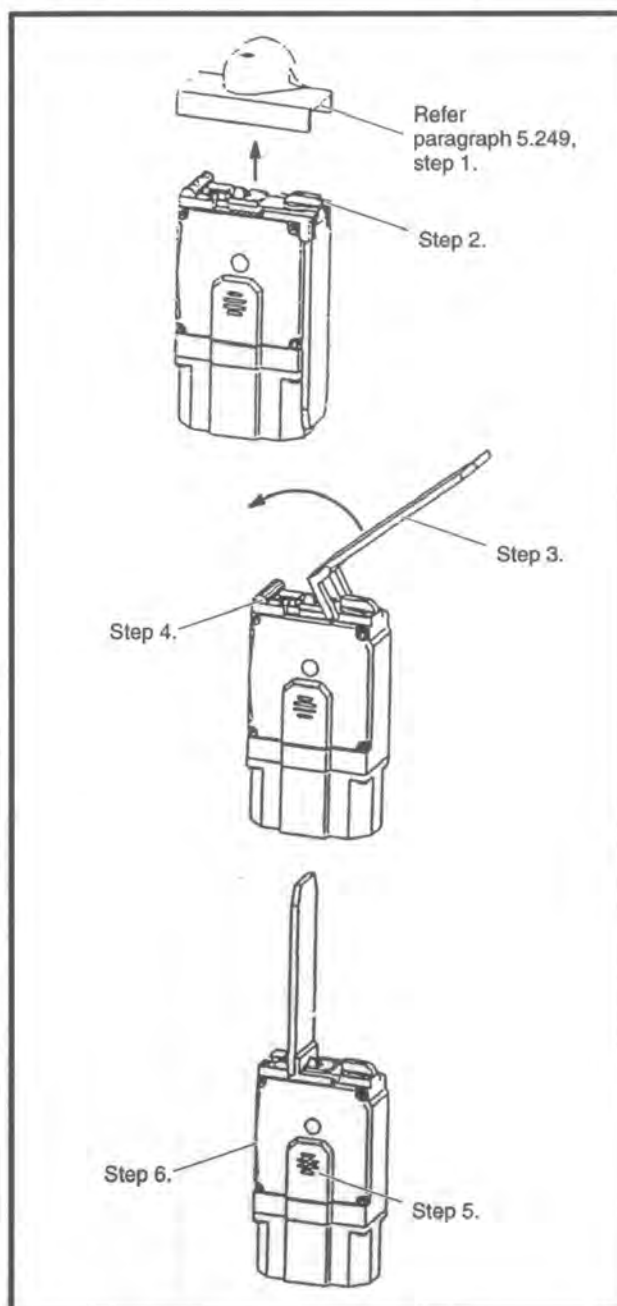


Figure 5-50 MR509 PLB – Operation with Integral Antenna



Figure 5-51 Becker MR509 PLB

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RESCUE

5.254 Prepare to abandon raft, and clear all equipment that may get tangled. Stay in the raft, let the rescue strop come to you.

WARNING

To allow discharge of static electricity and prevent electrical shock, do NOT touch helo-hoist cable or rescue device until it has made contact with water/ground.

To avoid severe injury, keep hands clear of D-ring and rescue hook after hooking up.



Figure 5-52 Stay In The Raft

1. Secure yourself in the rescue strop prior to disconnecting your lanyard from the raft.
2. Give thumbs up signal to helo-hoist operator.
3. Upon clearing ground/water, cross feet.

WARNING

Under no circumstances should survivors attempt to assist their entrance into the helicopter or move from the rescue device until helicopter aircrewman assists them to a seat in the aircraft.



Figure 5-53 Secure Rescue Strop And Disconnect Lanyard



Figure 5-54 Thumbs Up To Helo

AL 11(7)

DESCENT OVER LAND

5.255 Perform the same procedures as for over water, but with the following exceptions:

1. Visor – Down.
2. Do NOT deploy RSSK-8.
 - a. If landing in trees retain RSSK-8 for protection, penetrating the forest canopy.
 - b. Prior to landing over open ground release entire seat pan kit using the QRB.
3. During a low level ejection the priority action is to release the kit using the QRB.

Landing Preparation Over Land

5.256 When nearing the ground, attempt to manoeuvre the parachute so that you are facing into wind, then assume the proper body position for landing.

- a. Feet together.
- b. Knees slightly bent.
- c. Toes pointed slightly down.
- d. Eyes on horizon.
- e. Firmly grip parachute lift risers.



Figure 5-55 Release Kit Using QRB

- f. Tuck elbows in.
- g. Tuck chin into chest.

5.257 Upon touching ground surface:

1. Arch side of body in direction of fall.
2. Contact ground at five points of body.
 - a. Balls of feet.
 - b. Roll to sides of calves.
 - c. Roll to thighs.
 - d. Roll to buttocks.
 - e. Roll to shoulders.
3. Release parachute fittings.



Figure 5-56 Body Position For Landing

AL 11(8)

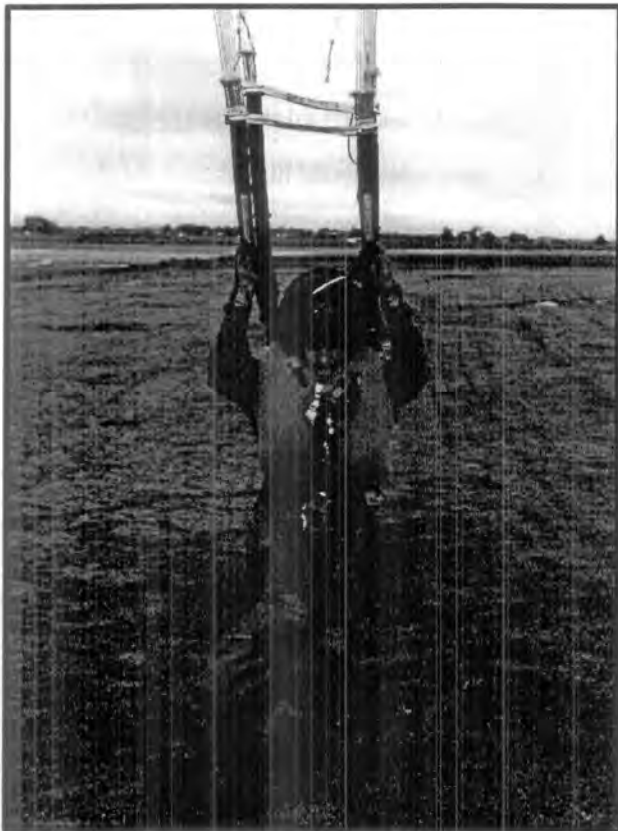


Figure 5-57 Roll to Sides of Calves

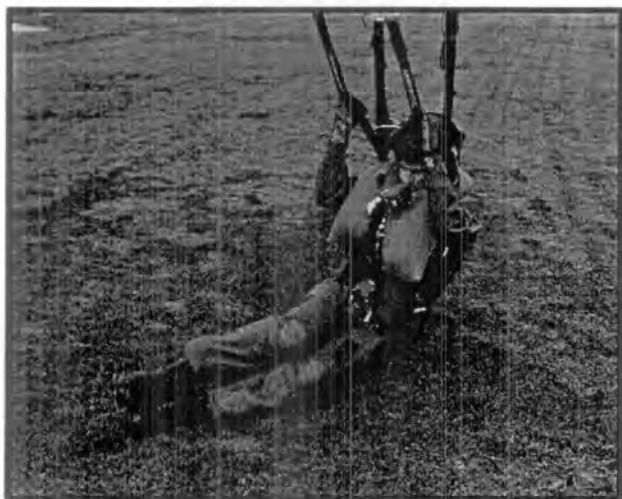


Figure 5-58 Continue to Roll onto Thighs and Buttocks

PERSONNEL LOWERING DEVICE (TREESCAPE)

5.258 When ejecting from an aircraft over heavily or even moderately wooded terrain, a hazard exists in the possibility of the parachute becoming entangled in the

branches or foliage of the trees. Though the ejectee may avoid injury from the contact with the trees, the subsequent entanglement of the parachute and/or rigging lines in foliage may result in the pilot being suspended above ground level and unable to complete a descent to safety. During peacetime operations the pilot may suffer circulation problems caused by tightness of the harness straps in the groin area and will also be at risk to hypothermia due to being exposed to the elements for a long period of time. During hostilities, the most critical time for escape and evasion is in the first few minutes after touchdown. If the pilot was unable to lower himself to the ground he would face almost certain capture.

5.259 The Treescape is a lanyard-based system which incorporates an anchor point which is attached to either a tree limb or threaded through the risers of the parachute, and a braking unit which is attached to the lifting webs on the pilots Life Preserver. The pilot then will operate the braking unit, release the Koch fittings, and control his descent to the ground.

Description

5.260 The Treescape system (Figure 5-59) is fitted to the RSSK-8A by six dome fasteners and consists of two main parts:

1. a seat covering (complete with stiffener pad) which houses the lowering lanyard, and

NOTE

This replaces the seat cushion but the lanyard packing provides almost identical comfort to the pilot as a cushion replacement.

2. a braking unit which is stowed in a pouch at the rear of the seat cushion.

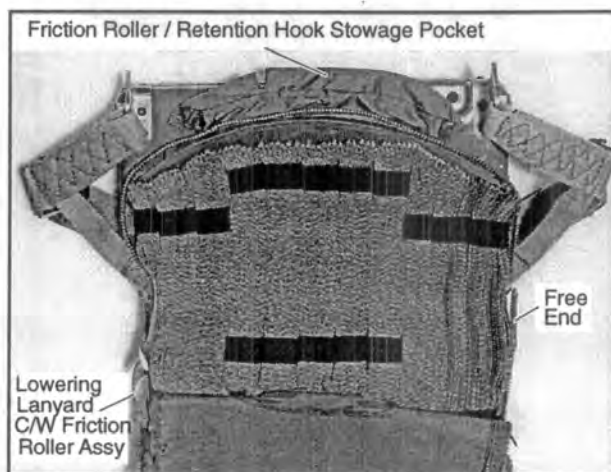


Figure 5-59 Lowering Lanyard Stowage

AL 11(8)

5.261 The Treescape consists of a nylon webbing lanyard (46.7 m x 20 mm complete with snap hook, retention ring and braking unit), one end of which is stitched to the seat cover and the remainder stowed in rows of elasticised beackets sewn to the cover, this is secured by a zip fastener.

5.262 A length of lowering lanyard is routed from the side of the pack, through location beackets and around the RSSK-8A right hand harness assembly strap through to a pouch at the rear of the seat cushion. Stowed in this pouch is a 580 mm length of lanyard to which a snap hook and 35 mm ring have been sewn, the remainder of the lowering lanyard has been routed through the braking unit. A 110 mm loop of lanyard is attached to the outer edge of the seat cushion by velcro. The pouch is closed by velcro.

5.263 The brake unit comprises a slider through which the lowering lanyard passes. This allows the pilot to fully control his rate of descent and can be operated single handed if required. A snap hook is riveted to the body for attachment to the Life Preserver lifting webs.

Operation

5.264 Should entanglement of parachute or harness in overhead growth or construction occur, carry out the following operations to ensure safe descent using the Treescape system:

1. Locate the lowering lanyard loop at the centre rear of the seat cushion.
2. Grasp lanyard loop and extract lowering device from the pouch and, once extracted, allow it to drop (approximately 1 – 1.5 m below the RSSK-8A lid).
3. Locate the right hand RSSK-8A harness lap strap. Move down the strap and locate the lanyard (this will be across the harness adjustment strap and held in position by velcro beackets). Retrieve the lowering lanyard.
4. Extract sufficient lowering lanyard and pass the lanyard over/through a convenient secure object. This will be either a tree branch or limb, or through the parachute risers. and snap the hook to retention ring of lanyard.

CAUTION

If a tree branch is selected ensure it will take the pilot's full weight.

5. Release sufficient CO₂ gas from the life preserver stole to gain access to the lifting webs. Locate the braking unit snap hook and fasten it to the lifting webs on the life preserver.

WARNING

Ensure the lifting webs are fully enclosed by the hooks safety lock before releasing the parachute Koch fittings.

6. Hold lanyard to ensure braking unit is providing security before release of any Koch fittings. Release Koch fittings one at a time with the free hand.
7. With the free hand gradually ease out the lowering lanyard from the beackets in the seat cushion and with the other hand, control your descent using the braking unit (refer Figure 5-60).
8. On reaching the ground, release the lowering lanyard from the Life Preserver lifting webs and retrieve RSSK-8A for collection of survival aids.



Figure 5-60 Treescape Lowering Device

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AL 8(3)

CHAPTER 6

TEST FLIGHT PROCEDURES

	PAGE		PAGE
FUNCTIONAL TEST FLIGHT PROCEDURES	6-1	Level at 15,000 Feet	6-11
FUNCTIONAL TEST FLIGHT REQUIREMENTS	6-1	Descending to 6,000 Feet	6-16
CONDITIONS REQUIRING FUNCTIONAL TEST FLIGHTS	6-1	6,000 Feet and below	6-16
AMENDMENTS	6-1	Climbing To 15,000 Feet	6-17
TEST FLIGHT PROCEDURES	6-2	Level at 15,000 Feet AGL + 2,500 Feet	6-17
Prior to External Checks	6-2	Airborne Test Procedure	6-19
Ejection Seat Checks	6-2	Aircraft Configuration	6-19
External Inspection	6-2	Aircraft Fuel Loading	6-20
Pre-Start Checks	6-2	Wind Conditions At Landing Airfield	6-20
Post-Start Checks	6-4	Test Procedure	6-20
Taxi Checks	6-8	Stick Forces	6-21
Pre-Takeoff Checks	6-8	Aircraft Nose Pitch Tendencies	6-21
Takeoff	6-9	Use Of Rudder In Controlling Rolling Moment	6-22
Climb	6-9	Landing Considerations And Aircraft Handling	6-23
Level at 36,000 Feet	6-10	Landing	6-23
Descending to 15,000 Feet	6-10	After Landing	6-24

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CHAPTER 6

TEST FLIGHT PROCEDURES**FUNCTIONAL TEST FLIGHT PROCEDURES****FUNCTIONAL TEST FLIGHT REQUIREMENTS**

6.1 A functional test flight is to be performed after the completion of appropriate maintenance using the applicable Functional Test Flight Checklist (NZAP 6213.001-5-12). This section contains a detailed description of the test flight requirements, sequenced in the order in which they are to be performed. However, at the completion of aircraft rework it is likely that two or more flights will be required to check all items. It is recommended that on the first flight items 1-51, 59-61, 63-85 be completed; and on the second flight items 52-58, 62, 86 and any items carried over from the first flight. Flight Manual procedures apply during the entire test flight.

CONDITIONS REQUIRING FUNCTIONAL TEST FLIGHTS

6.2 Test flights are required under the following conditions (after the necessary ground check and prior to release of the aircraft for operational use):

- a. Completion of aircraft rework or aircraft acceptance inspection. Required test flight items are prefixed A.
- b. Reinstallation of engine or reinstallation of fuel system components. Required test flight items are prefixed B.
- c. When fixed flight surfaces have been installed, movable flight control surfaces replaced, removed

for major repairs or rigged. When primary control cables, rods, or tubes have been replaced or rigged or when control system components have been adjusted and where improper adjustment or installation could adversely affect flight characteristics or result in loss of aircraft control. This profile is a composite profile for a multitude of aircraft systems. Individual steps may be omitted based on the nature of the maintenance action performed if that individual system is not affected (ie. a flight control hydraulic power disconnect is not required for a slat replacement or rudder power pack assembly replacement and vice versa. A slat check is not required for an aileron replacement (which requires a hydraulic power disconnect). Required test flight items are prefixed C.

NOTE

The requirement for a test flight, under circumstances other than those specified in the preceding is to be determined by an engineering officer in consultation with aircrew and will be based on the scope of the work accomplished and its effect on safety or reliability of operation.

AMENDMENTS

6.3 Amendments to this chapter require that amendments be raised for the NZAP 6213.001-5-12, Flight Test Schedule.

TESTFLIGHT PROCEDURES

PROFILE

NOTE

For normal checklist procedures refer to Chapter 2.

Prior to External Checks

- ABC 1. Normal checklist – COMPLETE

Ejection Seat Checks

- ABC 2. Normal checklist – COMPLETE

External Inspection

- ABC 3. Normal checklist – COMPLETE
A 4. External Lighting – CHECK

Pre-Start Checks

- ABC 5. Normal pre-start checks – COMPLETE

Ensure that location, security and where possible, the function of controls and the displays are correct. In addition carry out the following checks.

- A 6. INU – Carry out a GYRO COMPASS alignment.

- A 7. Throttle – CHECK

a. Operation of Master Mode Switch, Comms switch, Program Change Switch and Stadiametric Ranging

- A 8. Display Units – CHECK

a. Operation of brightness and Contrast Controls, and IDX and SEL functions.

9. Head Down Vertical Velocity Indicator – CHECK

Needle indicates 0 ± 100 FPM.

- A 10. Combined Speed Indicator – CHECK

Indices can be set.

- A 11. UFC – CHECK

a. Software loads are correct.

b. All Keys and BIT light function.

- A 12. HSI – CHECK

Heading Bug can be set.

- A 13. Liquid Oxygen Gauge – CHECK

a. Off flag is not visible with electrical power to gauge.

b. Quantity indication corresponds to known quantity. (If system serviced recently)

14. Cabin Altimeter – CHECK

Needle reads ± 200 ft (Sea Level), ± 300 ft (5 000 ft).

- A 15. Emergency Jettison Selector – CHECK

Selector aligned to ALL.

- A 16. Manual Weapons Switch – CHECK

Selector aligned to AUTO.

- | | |
|----|--|
| A | 17. Control Transfer Switches – CHECK
Control transfers to other cockpit (TA-4). |
| AB | 18. Pressure Ratio Indicator – CHECK
a. Indexer and counter should move smoothly when setting knob is rotated.
b. Index should agree with counter. |
| AB | 19. Fuel Quantity Indicator – CHECK
a. Pointer rotates smoothly counter-clockwise when master press-to-test is pressed.
b. Quantity displayed corresponds to actual fuel on board.
c. External fuel quantity indication is accurate. |
| A | 20. Countermeasures Dispenser Panel – CHECK
a. Load remaining counters operate.
b. Mode switches operate. |
| A | 21. ARC 159 – CHECK
a. Operation of READ/PRESET/MANUAL/GUARD selections.
b. Operation of SQUELCH control.
c. Operation of VOLUME control.
d. Operation of DIMMER control. |
| A | 22. Audio Panel – CHECK
Operation of HOT MIC, MUTE, ALT, ALT TX and VOLUMES. |
| A | 23. Internal Lighting – CHECK
Operation of INST, CONSOLE, WHITE and RED floodlights and UTIL light. |
| A | 24. AVTR – CHECK
a. With the AVTR in STBY check operation in the following modes.
1. RUN/HUD
2. RUN/RDR
3. AUTO/HUD
4. AUTO/RDR
5. AUTO in A/A
6. AUTO in A/G
b. With the AVTR in RECORD check operation in the following modes.
1. HUD
2. RDR |
| A | 25. Elapsed Time Clock – CHECK
Normal and elapsed time functions operate correctly. |
| A | 26. Standby Compass – CHECK
a. Heading error ± 3 degrees of HSI/HUD after magnetic deviation removed.
b. Fluid level – FULL |

AL 4(0)

Post-Start Checks

ABC

27. Normal checklist – COMPLETE

28. Canopy Locking Feature – CHECK

a. TA-4 – CHECK

1. Check that with rifle bolt forward and locked, canopy light out and all latches seated.
2. With pressurization switches on, ensure canopy seal inflated.

b. A-4 – CHECK

- 1 Canopy lever over-centre feature.
- 2 Canopy hook – roller engagement.

A

29. Built-In-Tests – COMPLETE

- a. Both AFCS Checks ensuring that the AFCS 1 tests operate in the rear cockpit of the TA-4 where applicable.
- b. I-BIT

NOTE

NAV Panel must be selected to NAS.

- c. AVTR View
- d. ADI – Turn needle deflects right
- e. RWS BIT – When BIT complete execute SA.
Check SA shown on CRT.
- f. Radar

AB

30. TA-4 Rear Cockpit Throttle Rigging – CHECK

With front cockpit throttle at idle hold rear cockpit throttle against stop. RPM decay should not exceed 2% RPM.

A C

31. Normal Trim Control Check

When all systems normally required for flight are functioning on aircraft power, the normal trim control checks of elevator, rudder and ailerons should be performed to ensure proper operation. During the actuation of these trim systems assistance of the groundcrew should be used to ensure correlation between trim settings and cockpit trim indicators. Ensure that horizontal stabilizer manual override operates correctly in both directions.

A C

32. Preflight Rigging Check

Based on the circumstances of the test flight the pilot should expect one of two initial rigging conditions to exist for aircraft preflight and the poststart rigging checks:

- a. Aircraft Rigged to Aircraft Mechanical Zero.

An initial rigging condition with ailerons and aileron trim tab set to zero. This situation will exist following the replacement of either aileron with a new or reworked aileron, structural repair to the aft spar or outboard portion of the wingtip, and other such times as determined by maintenance. Under these circumstances, with normal hydraulic and electrical power, (1) the ailerons will be positioned symmetrically with stick centred, (2) the aileron follow-up tab will be flush with the trailing edge of the left aileron, and (3) the aileron trim drum alignment notch will be at the nine o'clock position to the drum with equal wraps of the trim cable around the drum. All throws and operations are set at zero position.

When the ailerons are rigged to mechanical zero, the following procedures are performed during the testflight poststart checks to ensure that the aircraft is properly rigged.

1. Trim the ailerons full left wing down, observing that the right aileron moves down, the left aileron moves up, and the aileron follow-up tab moves down. Trim fully in the other direction and check for opposite movement.

WARNING

Ensure that aileron follow-up tab moves opposite to the left aileron (ie. the tab must move up when the aileron is trimmed down and vice versa). If the tab moves in the same direction as the left aileron as it is trimmed, it is rigged improperly; the aileron trim will function normally until hydraulic disconnect, after which the trim will operate in reverse, thus causing an increased rate of roll and a possible out of control situation if lateral trim is utilized.

2. Assisted by ground personnel, trim both ailerons symmetrically (i.e., both above or below an equal amount relative to the wing). Check the aileron follow-up tab to ensure that it is flush with the trailing edge of the left aileron when the ailerons are trimmed symmetrically with the wing.
3. Groundcrew should check to ensure that the aileron trim drum alignment notch is in the 9 o'clock position in the left wheelwell.
4. Check the control stick for centring (vertical) when ailerons are trimmed symmetrically with the wings.
5. Actuate all controls for maximum deflection and check for ease of movement to ensure that all systems are connected and functioning normally.

b. Aircraft Rigged to Other Than Aircraft Mechanical Zero.

A second condition exists when an airborne rate-of-roll check for the installed pair of ailerons has been performed previously and a rate-of-roll correction has been applied to the aircraft. Example: With the aircraft mechanical zero conditions set, an aircraft has a 12 degree per second rate of roll with left wing down at 300 KIAS. The proper maintenance corrective action is to adjust the aileron one-half out and two serrations counter-clockwise on the trim drum. This action results in a displacement of the aileron trim tab from the flush position to a position of approximately 2.15 degrees up from being flush with the ailerons. In general, a left rate-of-roll correction moves the trim tab up from the flush position, while a right rate-of-roll correction moves the trim tab down from the flush position.

The following procedures are than accomplished to ensure a proper rig in the same manner as with the ailerons and trim tab set to mechanical zero except that the pilot should expect to see the follow-up tab deflected in the direction indicated above.

1. Trim the ailerons full left wing down, observing that the right aileron moves down, the left aileron moves up, and the aileron follow-up tab moves down. Trim fully in the other direction and check for opposite movement.

WARNING

Ensure that aileron follow-up tab moves opposite to the left aileron (ie. the tab must move up when the aileron is trimmed down and vice versa). If the tab moves in the same direction as the left aileron as it is trimmed, it is rigged improperly; the aileron trim will function normally until hydraulic disconnect, after which the trim will operate in reverse, thus causing an increased rate of roll and a possible out of control situation if lateral trim is utilized.

2. Assisted by ground personnel, trim both ailerons symmetrically (i.e., both above or below an equal amount relative to the wing). Check the aileron follow-up tab for not more than 5 degrees (11/32 inch) deflection when the ailerons are trimmed symmetrically (in the above example, 2.15 degrees up). The pilot should actuate the aileron trim system on the ground and visually check that the 5 degree up and 5 degree down limits from the faired with the ailerons position are not exceeded. Activation of the trim system to the 5 degrees up and 5 degrees down limits (approximately 11/32 inch) will allow the pilot to visually calibrate his eye to the follow-up tab limit positions in preparation for again checking the tab within limits while airborne. Five degrees of tab deflection from the faired position is difficult to determine visually; therefore ground personnel should be briefed on what is required and should use accurate means to precisely position the follow-up tab at the 5 degree up and 5 degree down limits.
3. Check the control stick for centring (vertical) when ailerons are trimmed symmetrically with the wings.
4. Actuate all controls for maximum deflection and check for ease of movement to ensure that all systems are connected and functioning normally.

WARNING

If the control system does not meet the requirements of the above checks, the aircraft is out of rig and requires correction prior to flight.

NOTE

Because of the maintenance action required to correct a previous rate-of-roll, the alignment notch on the trim drum will not normally be at the 9 o'clock position to the trim drum.

c. Aircraft Logbook Neutral Trim Setting.

The aircraft logbook neutral setting is only valid for the installed set of ailerons. It is designed to provide a reference which will allow for removal of the ailerons to accomplish or facilitate such other maintenance as required. Upon reinstallation of the original set of ailerons, provided that no repair or modification has been made to either aileron, the logbook neutral setting is utilized during rerigging to ensure that proper rigging is maintained. Any replacement, repair or other maintenance action which will affect the contour of the ailerons, such as replacement of either the left or right aileron or repairs to either aileron, invalidates the logbook neutral setting for the aircraft. The aircraft must then be rigged to the initial mechanical zero position in accordance with current maintenance directives prior to conducting a flight control hydraulic power disconnect. For example, a rate-of-roll check results in a 1 degree right wing down rate of roll. This correction is entered into the aircraft logbook as rate of roll 1 degree right wing down. Follow-Up tab set at one-half turn out with two serrations counter-clockwise on the trim drum and is reflected by a 2.15 degrees up trim tab deflection. This entry is referred to as the aircraft logbook neutral setting.

WARNING

Use of the previous logbook neutral setting following replacement of either aileron may result in an out-of-control flight situation following a flight control hydraulic power disconnect. Logbook neutral trim tab setting deflections are valid only for the installed pair of ailerons. Any rework to flight control surfaces or replacement of ailerons, either right or left, invalidates this setting.

A

33. NAS Panel – CHECK

With INU alignment complete, the NAS switched to NAV, and with an appropriate steer-to-destination, steering on the HUD, HSI and ADI should be consistent and correct. Data window R1 should show the appropriate word for each of:

NOTE

The route structure for this test will require that a W and an I/O combination be available and that a navaid can be received.

- a. NAS reference; PLANNED, DIRECT, and FIXED course
- b. NAVAID reference
- c. OFST NAVAID reference (with an appropriate offset entered)
- d. In NAVAID reference data window L2 shows HOLD when DME hold selected

AL 4(0)

Taxi Checks

ABC

34. Normal checklist – COMPLETE

A

35. Spoilers – CHECK

Normal Operation (ARM position). Actuation should occur with landing gear struts compressed, and throttle below 70% RPM position.

NOTE

The technical tolerance for adjusting spoiler operation falls within 5% RPM band. i.e., between 65%–70% RPM throttle position. Although spoiler operation at 65% is within technical limits, rigging for spoiler operation at 70% should be obtained if possible.

A

36. Brakes – CHECK

- a. Brake pedal travel 1 1/2 inches maximum prior to braking action.
- b. Hold facility and warning light.

A

37. Nosewheel Steering – CHECK

- a. Engage (Emergency control switch in NORMAL position, and steering control switch depressed.)
 - 1. Transients (Directional transients from tracking during taxi, landing, or takeoff roll not acceptable.)
 - 2. Pedal Deflection (Verify that aircraft tracks in direction of applied rudder.)
 - 3. Nosewheel Deflection (Verify that aircraft tracks in direction of applied rudder when arresting hook is lowered.)
- b. Disengage (Control switch released.)
 - 1. Castering (Aircraft should track smoothly in direction of applied braking.)
- c. Emergency OFF
 - 1. **EMER OFF** Position (Nosewheel steering should disengage when steering switch is placed in **EMER OFF** position.)

Pre-Takeoff Checks

ABC

38. Takeoff Checklist – COMPLETE

AB

39. Manual Fuel Control Checks

- a. Idle RPM – RECORD
- b. Switch to manual fuel control at 65% RPM.
- c. Occurrence of compressor stall is unacceptable.
- d. Reduce power to idle.

CAUTION

Do not allow engine to decelerate below 51% to prevent flame out.

- e. Switch back to **PRIMARY** at 80 to 85% rpm. Manual fuel control warning light should go off. If compressor stall occurs, return to **MANUAL** and position throttle to 78% RPM. Return throttle to **IDLE**, and while engine is decelerating, attempt another changeover. Occurrence of compressor stall is unacceptable.

40. 85% RPM. Check no aircraft forward movement. Spongy, chattering, fading, or dragging brake unacceptable.

AB

41. Anti-Icing System and Pressurization Checks.

- a. At a stabilized RPM above 80%, activate forward cockpit anti-icing switch to **ALL**, and observe slight drop in EPR.
- b. Turn anti-icing switch to **PITOT**, and observe slight rise in EPR.
- c. Reduce throttle quickly to idle.
- d. Idle RPM – RECORD
- e. Note hang-up or abrupt increase.

A malfunctioning fuel control may cause RPM to remain below or abruptly increase to previous idle RPM.

NOTE

If fuel control hang-up occurs, the aircraft is to be placed unserviceable and not flown.

Takeoff

AB

42. Engine Acceleration From Idle – CHECK

NOTE

For individual engine limitations refer to Chapter 4 of this manual.

- a. Slam Acceleration Check (13 seconds maximum) – RECORD (Idle to Military RPM)
- b. EPR – CHECK at or above minimum.
- c. At Liftoff
 1. EPR – RECORD
 2. RPM – RECORD
 3. Oil Pressure – RECORD
 4. EGT – RECORD
 3. Fuel Flow – RECORD

Climb**NOTE**

For purposes of Functional Check flights, a climb schedule of 300 KIAS to 0.72 IMN is recommended.

AB

43. Climbing through 16,000 feet

- a. EPR – RECORD
- b. RPM – RECORD
- c. Oil Pressure – RECORD
- d. EGT – RECORD
- e. Fuel Flow – RECORD
- f. Pressurization – RECORD (8,000 ± 1,000 feet)

- AB 44. Climbing through 26,000 feet
- a. EPR – RECORD
 - b. RPM – RECORD
 - c. Oil Pressure – RECORD
 - d. EGT – RECORD
 - e. Fuel Flow – RECORD
 - f. Pressurization – RECORD (14,000 + 1,300, -1,800 feet)

Level at 36,000 Feet

- AB 45. Airspeed/Mach – RECORD (Indication of 237 ± 2 KIAS at 0.72 IMN.)

- AB 46. Military
- a. EPR – RECORD
 - b. RPM – RECORD
 - c. Oil Pressure – RECORD
 - d. EGT – RECORD
 - e. Fuel Flow – RECORD

- AB 47. Idle (70% RPM/180 KIAS minimum)
- a. EPR – RECORD
 - b. RPM – RECORD
 - c. Oil Pressure – RECORD
 - d. EGT – RECORD
 - e. Fuel Flow – RECORD
 - f. Pressurization – RECORD (20,000 +1 600, -2,600 feet)

- AB 48. Slam Acceleration Check (20 seconds maximum)

Descending to 15,000 Feet

- A C 49. Flight Control Check

Noseover to obtain 0.90 IMN and check flight controls for proper response. Observe Flight Manual restrictions shown in Chapter 4.

CAUTION

Do not exceed 0.90 IMN with external tanks installed.

- AB 50. Anti-G System – CHECK

Ensure anti-g suit inflates under positive acceleration.

Level at 15,000 Feet

A C

51. Speedbrakes – CHECK

Check in 1.0g flight at 400 KIAS.

- a. Open (3 seconds maximum).
- b. Close (3 seconds maximum).
- c. Pitch (open +1.0g, -0.5g maximum; close -0.5g maximum).
- d. Yaw (1/2 ball).
- e. Roll (5 degrees per second maximum).

A

52. APX-72 IFF – CHECK

- a. Check identification modes with available interrogating stations.
- b. Check emergency feature.

A

53. ARN-118 TACAN – CHECK (with antenna in AUTO position) for both NAS control and panel control

- a. Operational range 150 to 300 nautical miles.
- b. Check as many channels as possible.
- c. No flag showing on the HSI when range indication is operating.
- d. Volume control operative.
- e. Auto antenna lock-on 9 seconds maximum, with usable signal.
- f. Air-to-air mode, range lock-on with cooperating aircraft or station.

A

54. APG 66(NZ) Radar – CHECK

- a. Master Mode – NAV
 - 1. Mode switch changes radar mode correctly with each selection. Select **AUTO**.
 - 2. Range switch changes range correctly with each selection.
 - 3. Coarse Gain increases gain with clockwise rotation and decreases with counter-clockwise rotation.
 - 4. Freeze Facility freezes GM when selected. Heading at freeze selection shown at bottom right of DU and aircraft bug displayed.
 - 5. Antenna Azimuth marker shows correct scan for ± 60 degrees, ± 30 degrees, and ± 10 degrees scans.
 - 6. Slew Control moves cursors up for upward pressure on the slew controller, down for downward pressure, left for left pressure and right for right pressure; and in a controllable manner.
 - 7. Undesignate returns cursors to middle of DU.
 - 8. Marker Intensity depression changes range marker intensity.
 - 9. Control Column Mode change selects AGR. Toggle to GM.
 - 10. Return to Search selects Expanded GM and DBS dependant on range scale set.

	b. Radar Mode – AIR 1. MKR INT changes MTL. 2. Antenna Tilt increases search altitudes with upwards rotation and decreases altitudes with downwards rotation. 3. Elevation Bar operates correctly for 1, 2 and 4 bar scans as shown by the antenna elevation marker. 4. PRF regulates the number of false targets. 5. DESIGNATE switch depression with acquisition corral bracketing a valid target results in target acquisition (STT or SAM). 6. With target acquired radar breaks track at ± 60 degrees azimuth and elevation. 7. Target History operates correctly. c. Radar mode – SEA 1 or SEA 2 MTT dependant on altitude/sea state. 1. HUD Target Diamond overlays target.
A	55. ADI – CHECK a. Turn needle correlates for rate 1 turn with no jitters/hang-up. b. Vertical gyro precession after 180 degree, 4 minute turn less than ± 3 degrees in roll or pitch with no jitters/hang-up.
A	56. VIR 130 – CHECK a. Navaid mode operation when paired with the TACAN and when tuned individually. b. ILS channel/freq can be tuned. c. Comm mode operation.
A	57. ARC 182 VHF/UHF Radio – CHECK Transmission and reception satisfactory in all bands.
A	58. ARC 159 UHF Radio – CHECK a. Transmission and reception. b. ADF function.
AB	59. Drop Tank Transfer – CHECK a. Ensure all external fuel tanks transfer properly. b. Ensure all external fuel quantity can be monitored.

AL 4(2)

AB

60. Slam Acceleration Check (180 KIAS minimum).

- a. Idle (70% RPM minimum)
 - 1. EPR – RECORD
 - 2. RPM – RECORD
 - 3. Oil Pressure – RECORD
 - 4. EGT – RECORD
 - 5. Fuel Flow – RECORD
 - 6. Pressurization – RECORD (8,000 ± 1,000 feet)
- b. Slam Acceleration Check (20 seconds maximum) (IDLE to MILITARY) – RECORD
- c. Military – RECORD
 - 1. EPR – RECORD
 - 2. RPM – RECORD
 - 3. Oil Pressure – RECORD
 - 4. EGT – RECORD
 - 5. Fuel Flow – RECORD

A C

61. Slow Flight Check

- a. Landing Gear – CHECK
 - 1. Gear down (5 to 11 seconds)
- b. Wing Slats – CHECK
 - 1. Slats should commence opening at approximately 160–180 KIAS, are $1/2$ open at optimum AOA, and are fully open at stalling speed.
- c. Landing Flaps – CHECK
 - 1. Flaps down 10 seconds maximum (160 KIAS and under).
- d. Angle-of-Attack System – CHECK
 - 1. Check AOA system for proper operation.
 - 2. All indexer lights come on when press-to-test button is pressed.
 - 3. Record fuel weight and airspeed at optimum AOA (4 degree descent). See Figure 9-80 for airspeed/AOA relationship.
- e. Landing Gear – CHECK
 - 1. Gear up 14 seconds maximum (210 KIAS).
- f. Flap blowback – CHECK
 - 1. Indication of blowback should occur at approximately 230 KIAS. Maximum permissible speed without flap blowback indication is 240 KIAS.
- g. Wheels Warning Light – CHECK
 - 1. The wheels warning light flashes when the throttle is retarded below 96–91%, if the wing flap handle is not in the UP detent and the landing gear is UP or unsafe.
- h. Landing Flaps – CHECK
 - 1. Flaps up 7 seconds maximum (160 KIAS and under).

A

62. Automatic Flight Control System (AFCS) – CHECK

- a. Stability Augmentation – CHECK
 - 1. Engage. No aircraft upset (rudder thump acceptable).
 - 2. False rudder (no apparent oscillation remaining after 2 cycles.
 - 3. Disengage (no aircraft upset, rudder thump acceptable.)
- b. AFCS Engage and Disengage Transients – CHECK
 - 1. Trimmed straight and level flight ± 0.5 degree bank upset. No pitch upset.
 - 2. Trimmed flight not straight and level (bank angle less than 70 degrees, ± 2.0 degree bank upset. Pitch angle less than 60 degrees, $\pm 0.5g$ pitch upset.)
- c. Heading Hold Mode – CHECK
 - 1. Will not engage (no force on control stick). Bank angle over 7.0 degrees.
 - 2. Must engage (no force on control stick). Bank angle under 3.0 degrees.
 - 3. Upon engagement (will seek and hold engage heading ± 1.0 degree.)
- d. Attitude Hold Mode – CHECK
 - 1. Holds established pitch angle (within 60 degrees nose-up to 60 degrees nose-down) (± 1.0 degree).
 - 2. Holds established bank angle (within 5 to 70 degrees left or right) (± 2.0 degrees).
- e. Preselect Heading Mode – CHECK
 - 1. Upon engagement (aircraft should turn in the direction for smallest heading change).
 - 2. During turn (bank angle 27 ± 5.0 degrees established bank and pitch angles remain constant ± 2.0 degrees)
 - 3. During rollout (rollout completed to selected heading within 20 seconds).
 - 4. Following rollout (established heading should be ± 1.0 degree of preselected heading).
 - 5. Disengage Preselect Heading switch during turn (aircraft returns to approximately wings-level flight within 20 seconds).
 - 6. Maximum rate of roll at any time while on Preselect Heading mode (40 degrees per second).
- f. Altitude Hold Mode – CHECK
 - 1. Steady state climb or dive over 4,500 FPM (will not engage).
 - 2. Steady state climb or dive under 3,500 FPM (must engage).
 - 3. Damping upon engagement during climb or dive (1 to 1/10 cycle amplitude).
 - 4. Load factor during damping ($\pm 0.5g$ from steady state load factor at engagement).
 - 5. Residual oscillation (level flight ± 25 feet or $\pm 5\%$ of altitude with maximum frequency of 3 cpm).

AB

60. Slam Acceleration Check (180 KIAS minimum).

- a. Idle (70% RPM minimum)
 - 1. EPR – RECORD
 - 2. RPM – RECORD
 - 3. Oil Pressure – RECORD
 - 4. EGT – RECORD
 - 5. Fuel Flow – RECORD
 - 6. Pressurization – RECORD (8,000 $\pm$ 1,000 feet)
- b. Slam Acceleration Check (20 seconds maximum) (IDLE to MILITARY) – RECORD
- c. Military – RECORD
 - 1. EPR – RECORD
 - 2. RPM – RECORD
 - 3. Oil Pressure – RECORD
 - 4. EGT – RECORD
 - 5. Fuel Flow – RECORD

A C

61. Slow Flight Check

- a. Landing Gear – CHECK
 - 1. Gear down (5 to 11 seconds)
- b. Wing Slats – CHECK
 - 1. Slats should commence opening at approximately 160–180 KIAS, are $\frac{1}{2}$ open at optimum AOA, and are fully open at stalling speed.
- c. Landing Flaps – CHECK
 - 1. Flaps down 10 seconds maximum (160 KIAS and under).
- d. Angle-of-Attack System – CHECK
 - 1. Check AOA system for proper operation.
 - 2. All indexer lights come on when press-to-test button is pressed.
 - 3. Record fuel weight and airspeed at optimum AOA (4 degree descent). See Figure 9–80 for airspeed/AOA relationship.
- e. Landing Gear – CHECK
 - 1. Gear up 14 seconds maximum (210 KIAS).
- f. Flap blowback – CHECK
 - 1. Indication of blowback should occur at approximately 230 KIAS. Maximum permissible speed without flap blowback indication is 240 KIAS.
- g. Wheels Warning Light – CHECK
 - 1. Ensure that the wheels warning light flashes when the flap handle is out of the UP position, gear is up, and throttle is retarded below 92% $\pm$ 1% RPM. Advance the throttle past 92% RPM; wheels warning light should go out.
- h. Landing Flaps – CHECK
 - 1. Flaps up 7 seconds maximum (160 KIAS and under).

A

62. Automatic Flight Control System (AFCS) – CHECK

- a. Stability Augmentation – CHECK
 - 1. Engage. No aircraft upset (rudder thump acceptable).
 - 2. False rudder (no apparent oscillation remaining after 2 cycles).
 - 3. Disengage (no aircraft upset, rudder thump acceptable.)
- b. AFCS Engage and Disengage Transients – CHECK
 - 1. Trimmed straight and level flight ± 0.5 degree bank upset. No pitch upset.
 - 2. Trimmed flight not straight and level (bank angle less than 70 degrees, ± 2.0 degree bank upset. Pitch angle less than 60 degrees, $\pm 0.5g$ pitch upset.)
- c. Heading Hold Mode – CHECK
 - 1. Will not engage (no force on control stick). Bank angle over 7.0 degrees.
 - 2. Must engage (no force on control stick). Bank angle under 3.0 degrees.
 - 3. Upon engagement (will seek and hold engage heading ± 1.0 degree.)
- d. Attitude Hold Mode – CHECK
 - 1. Holds established pitch angle (within 60 degrees nose-up to 60 degrees nose-down) (± 1.0 degree).
 - 2. Holds established bank angle (within 5 to 70 degrees left or right) (± 2.0 degrees).
- e. Preselect Heading Mode – CHECK
 - 1. Upon engagement (aircraft should turn in the direction for smallest heading change).
 - 2. During turn (bank angle 27 ± 5.0 degrees established bank and pitch angles remain constant ± 2.0 degrees)
 - 3. During rollout (rollout completed to selected heading within 20 seconds).
 - 4. Following rollout (established heading should be ± 1.0 degree of preselected heading).
 - 5. Disengage Preselect Heading switch during turn (aircraft returns to approximately wings-level flight within 20 seconds).
 - 6. Maximum rate of roll at any time while on Preselect Heading mode (40 degrees per second).
- f. Altitude Hold Mode – CHECK
 - 1. Steady state climb or dive over 4,500 FPM (will not engage).
 - 2. Steady state climb or dive under 3,500 FPM (must engage).
 - 3. Damping upon engagement during climb or dive (1 to 1/10 cycle amplitude).
 - 4. Load factor during damping ($\pm 0.5g$ from steady state load factor at engagement).
 - 5. Residual oscillation (level flight ± 25 feet or $\pm 5\%$ of altitude with maximum frequency of 3 cpm).

g. Control Stick Steering (CSS) Mode – CHECK

NOTE

Force measurements are given as a guide in making qualitative estimates only.

1. CSS breakout force
Long/Lat (2 ± 0.5 pounds).
2. CSS stick force
Longitudinal (50 to 120% of normal system forces).
Lateral (80 to 120% of normal forces).
3. Feedback (qualitative evaluation).

NOTE

Feedback is defined as a lateral oscillation of the control stick, 1 to 3 cps, that the pilot feels and sees while manoeuvring the aircraft in the lateral direction in the CSS mode. This does not include any transient control inputs caused by CSS engagement or disengagement (CSS "Break-in or Breakout").

h. Residual Oscillations – CHECK

1. With hands off control stick and while using heading hold, preselect heading or attitude hold modes (± 0.5 degree lateral at approximately 2 to 4 cps. No pitch oscillation).
2. Due to external lights flashing (± 0.75 degree lateral at approximately 1 cps. No pitch oscillation. Resultant stick motion acceptable).

i. Automatic Pitch Trim – CHECK

Time lag for trim operation after new attitude is established, and period between operations is 5 ± 2 seconds (no transients).

j. Longitudinal Structural Protection – CHECK

1. Windup turn on CSS mode without centreline store (disengage 4 ± 0.5 g).
With centreline store (disengage 3.5 ± 0.5 g).
2. Attitude hold mode (disengage $+3.5 \pm 0.5$ g) (-1.0 ± 0.5 g).

k. Lateral Structural Protection (AFCS lateral control approximately 1/2-stick throw, or 40-pounds stick force).

l. Speedbrake Compensation – CHECK.

1. With AFCS engaged, open speedbrakes (± 0.5 g maximum pitch).
2. With AFCS engaged, close speedbrakes (± 0.5 g maximum Pitch).

m. NAS Steering

1. AFCS Steer Toggles ON when all of the following conditions are met.
 - (a) Preselect Heading Hold mode is OFF,
 - (b) A valid TAE signal is being received, and
 - (c) The AFCS is engaged.
2. Must toggle OFF when any of the following conditions are met.
 - (a) AFCS engage switch is selected OFF.
 - (b) TAE signal becomes invalid.
 - (c) Control stick is overridden.
 - (d) DU softkey is toggled OFF.
 - (e) AFCS heading hold mode is ON.
 - (f) AP button on control stick depressed.
 - (g) Aileron trim NORM/EMERG switch selected to EMERG.
 - (h) AFCS standby switch selected OFF.
3. Aircraft response should be the same as in Preselect mode.
4. Track re-capture occurs in Nav, A/G and A/A master modes, and in NAS (W.I.O.N AND M points) NAVAID and OFFSET NAVAID steering.

Descending to 6,000 Feet

- A 63. Vertical Velocity Indicator – CHECK ± 300 fpm during 2 000 fpm climb or descent.

6,000 Feet and below

- AB 64. Approach Check

6 000 feet at 150 KIAS, approximately 75% RPM with gear and flaps down.

- a. Slam Acceleration Check (5 seconds maximum) – RECORD

- A 65. AN/APN-141 Radar Altimeter – CHECK

- a. Cross check with pressure altimeter for approximate correlation.
- b. Dropout should not occur at pitch or bank angles less than 45 degrees.
- c. Operation
 1. Above 5,000 feet (No readout)
 2. Below 5,000 feet (smooth tracking of terrain clearance without readout noise).
 3. Audio sounds for 2 seconds when aircraft passes inserted LAWS altitude.
 4. Readout flashes when aircraft is below preset terrain clearance altitude.

- d. RAD ALT Switch – CHECK Operation.

With the Master Mode in A/G, radar in STBY or OFF, and a CCIP or DVTS program selected HUD ranging sensor indicates radalt sensing in use with radalt selected to WPNS, and Baro/Inertial sensing in use when radalt selected to RADALT.

- A 66. Salt Removal – CHECK Operation.

- A 67. Control Column Overfly Position – CHECK

Perform overfly Update/ Mark to check O'fly switch.

AL 4(0)

Climbing to 15,000 Feet

AB

68. Fuel Dump – CHECK

WARNING

Dumping wing fuel above the freezing level may result in the dump valve freezing open. Fuel dump will then continue until the wing tank fuel is depleted, or descent is made below the freezing level.

- a. Turn on Fuel Dump.
 - 1. Note drop in internal fuel quantity, and slight buffet from fuel leaving the dump mast.
- b. Secure fuel dump. Fuel quantity should stabilize and the slight buffeting cease.

AB

69. Emergency Fuel Transfer – CHECK

This check is to be carried out with internal fuel contents of between 2,000 lbs and 4,000 lbs.

- a. Select EMERG TRANS and maintain level flight for 90 seconds. Check for signs of fuel dumping or heavy venting.
- b. Return switch to OFF after 90 seconds or when dumping/venting occurs.
- c. Occurrence of dumping/venting – RECORD

Level at 15,000 Feet AGL $\pm$ 2,500 Feet

A C

70. Proper Slat Operation – CHECK (NAS slat data trap should be used during slat check).

- a. At 250 KIAS
 - 1. Trim aircraft directionally, to centre the ball.
 - 2. Perform constant airspeed left and right turns while steadily increasing g.
 - (a) Slat extension (12 to 14 units AOA).
 - (b) Maximum allowable AOA split between left and right slat opening (less than 1 unit).
 - 3. If slat performance satisfactory – proceed to 300 KIAS.

b. At 300 KIAS

Repeat the check.

- 1. Slat extension (13 to 16 units AOA).
- 2. Maximum allowable AOA split between left and right slat opening (less than 1 unit)
- 3. Maximum bank angle change due to asymmetric slat extension – 20 degrees.

A C

71. Trim – CHECK

- a. At 300 KIAS, trim aircraft for hands-off, straight and level flight (2,000 to 4,000 pounds fuel load recommended) – CHECK
 - 1. Rudder trim indication – RECORD (0 ± 1.0 degree).
 - 2. Elevator trim indication – RECORD ($1 \pm 1/2$ degree noseup without wing drop tanks, or $1/2 \pm 1/2$ degree noseup with wing drop tanks).
- b. Aileron Power Configuration – CHECK
 - 1. Breakout force (3.8 pounds maximum).
 - 2. Control stick free play ($1/8$ inch maximum).
- c. Elevator Power Configuration – CHECK
 - 1. Breakout force (3.8 pounds maximum).
 - 2. Control stick free play ($3/8$ inch maximum).

AL 8(6)

- d. Rudder System – CHECK
 1. Breakout force (7 to 13 pounds).
 2. Control free play ($\frac{1}{4}$ inch maximum).

NOTE

Force measurements are given for guidance in making qualitative assessments only.

A C

72. Emergency Generator – CHECK

NOTE

An emergency generator check should be performed just prior to a hydraulic power disconnect.

To preserve core data, the DTM should be downloaded prior to the RAT check being carried out.

The ARC-182 radio can blow fuses during the changover of electrical power from normal generator power to emergency generator power.

- a. Turn off ARC-182 radio.
- b. Unload the DTM, via the UFC.
- c. The DTM should be ejected from its housing during the RAT check to prevent corruption of stored data. Commence the emergency generator check with the aircraft in the landing configuration at 150 KIAS, with the ARC 159 on an unused frequency, and with all lights and avionics equipment on except for AFCS and horizontal trim. Extend the emergency generator.

NOTE

Lights should fail and warning flags should appear almost simultaneously with ARC 159 fade-out. Large airspeed spreads between events may indicate marginal systems.

- d. Extend the emergency generator.
- e. Reduce power to idle, keeping ARC 159 keyed (slow aircraft to 130 KIAS, side tone should not fade out).
- f. With emergency generator deployed, attempt to trim the aircraft. Normal aircraft trim system should be inoperative.

WARNING

With emergency generator deployed and the generator bypass switch in the NORMAL position, normal aircraft trim should not be available. If normal trim operation occurs, a failure has occurred which negates the ability of the emergency generator to act as a limiting device in the event of a runaway trim condition. The flight control hydraulic disconnect should not be performed if this condition exists.

AL 8(6)

- g. Check operation of IFF on RAT through Air Traffic Control. (IFF should operate on the RAT.)
- h. Check HSI for continued INU performance. (Compass should still indicate correct heading through INU. IF HSI frozen on 360° or incorrect, INU battery probably u/s.)
- i. Check generator or bypass switch operation. Normal generator operation should be regained.
- j. Check that normal trim functions are regained.
- k. Turn on ARC-182 and check operation.
- l. Do not re-insert DTM into housing. Do not re-load DTM. Do not unload DTM after landing.

A C

73. Flight Control Disconnect

This procedure is designed to be performed in conjunction with the normal test flight procedure. Items repeated from the normal procedure are either those which are exceedingly important in the proper performance of this check or are those which are part of the normal flight check procedure but for which additional checks are necessary.

Airborne Test Procedure

While other flight control surfaces affect the aircraft rate of roll, the primary factor generally determining the rate of roll an aircraft will experience is the effect of the aerodynamic forces on the ailerons following disconnect from the hydraulic boost system. Until the moment of disconnect, the aircraft roll tendencies are corrected by the hydraulic boost system and the trim system. Upon disconnect, the ailerons will seek their aerodynamic neutral positions which will be reflected to the pilot by the transmission of stick forces through the mechanical cable system and by a tendency of the aircraft to roll in either direction. The resulting rolling moment may be caused by either one or both of the ailerons.

Aircraft Configuration

The aircraft is to be symmetrically configured during a maintenance disconnect. Installation of either a centreline drop tank or two wing station drop tanks is permissible when local operating procedures or conditions necessitate their use. However, all external tanks must be empty prior to the disconnect. Under no circumstances is the disconnect to be performed with an asymmetric wing loading.

WARNING

A flight control hydraulic disconnect performed with asymmetric wing loading or with fuel trapped in external drop tank may result in an out-of-limits rate of roll following the disconnect.

Aircraft Fuel Loading

Hydraulic power disconnects should be performed with the internal wing fuel tanks as close to empty as practical in order to avoid the possibility of fuel being displaced to a descending wing resulting in an increased rate of roll. To provide uniformity between test flights, it is recommended that the disconnect check be commenced with 2000 pounds of fuel remaining. However, with greater fuel loads the rate of roll check may be safely performed provided that symmetrical wing loading is maintained.

Wind Conditions At Landing Airfield

A crosswind component of 8 knots is considered the maximum for a safe disconnect landing if a short field arrest is not available. An arrest must be available in crosswinds exceeding 8 knots before a hydraulic power disconnect is performed. When contacting the tower or ground control, the pilot should request the wind direction in degrees magnetic, the wind velocity, the active runway, and other pertinent information such as into-wind runway availability and any forecast wind shifts and gusting. It should always be anticipated that a disconnect will result in reduced control of the aircraft. If any condition exists that would further complicate the landing, the check should not be performed. In particular, the disconnect should not be conducted if there is a possibility of encountering gusty wind conditions on landing.

AL 8 (0)

Test Procedure

After contact with the tower has been established and the active runway has been determined, proceed in the following manner. Prior to performing a flight control hydraulic disconnect under controlled conditions, the emergency generator should be extended and a functional check of the emergency trim override should be conducted. If the emergency trim functions properly on emergency generator power, select bypass and continue with the disconnect.

WARNING

Do not attempt flight control hydraulic power disconnect while operating on the emergency generator unless an emergency condition exists. Do not attempt a flight control hydraulic power disconnect if the emergency generator is inoperative. Do not attempt a flight control hydraulic power disconnect if normal trim operation is not regained following the emergency generator check and the emergency generator bypass switch is not in the bypass position.

- a. Establish a minimum safe altitude of 15,000 feet AGL or above with a minimum amount of fuel in the wing.
- b. Trim for hands-off, straight and level flight at 300 KIAS. Note the rudder and elevator settings.
- c. Visually check the follow-up tab for 5 degrees maximum deflection from being faired with the port aileron. A 5 degree deflection of the follow-up tab from faired with the aileron is approximately 11/32 inch and should have been determined during the poststart rigging check as previously discussed. If the follow-up tab is deflected more than 5 degrees when the aircraft is trimmed for hands-off, straight and level flight at 300 KIAS, the hydraulic system should not be disconnected since an excessive rate of roll will probably occur. The 5 degree maximum deflection limit applies to all models of the aircraft.
- d. Slow to 200 KIAS. Do not retrim the aircraft during deceleration. Deceleration to 200 KIAS for the actual disconnect is for safety in the event an excessive rate of roll occurs. The aircraft becomes more controllable at slower airspeeds and there is less chance of overstressing the aircraft if an erratic condition occurs. Deceleration should be accomplished without the use of speedbrakes. The speedbrakes are interconnected with the elevator and a possible trim change may occur following their extension and retraction. Slowing to 200 KIAS should be accomplished in a slight climb (of no more than 5 to 10 degrees nose up) until 200 KIAS is reached. Releasing the pressure on the control stick and pulling the flight control hydraulic power disconnect handle with the aircraft nose slightly above the horizon provides the pilot increased response time and improved aircraft controllability following the disconnect. The slightly nose high attitude will compensate for the nose pitchdown which occurs at the moment of disconnect. A slightly nose-high attitude will have a negligible effect on both the aircraft handling and rate of roll provided that a wings level attitude is maintained.

CAUTION

Hold the hydraulic power disconnect T-handle while allowing handle to return to the stowed position. This procedure is to prevent handle striking an instrument.

AL 8 (0)

- e. Pull the hydraulic power disconnect handle. The hydraulic power disconnect handle should be pulled smartly to ensure a proper disconnect. Pulling the handle slowly may result in a partial disconnect that could cause a hazardous flight condition or an erratic rate of roll. Ensure that there is no pressure on the control stick when the disconnect handle is pulled. Normally the disconnect cable will extend approximately 12 inches for a complete disconnect and two slight jolts will be felt, evidencing disconnect of aileron and elevator hydraulic systems in that order. It is emphasized that the hydraulic power disconnect handle should be pulled smartly and that no attempt to hesitate between each system disconnect should be made.

Stick Forces

While the stick forces following a hydraulic power disconnect may be quite high, the resulting rate of roll may not necessarily correlate with the lateral forces observed. However, when lateral stick forces are present, the rate-of-roll check should be conducted at an airspeed of less than 300 KIAS. Aileron trim should not be used after disconnect if the aircraft is controllable. If the pilot feels that the rate of roll will be controllable at 200 KIAS, the check at that speed may be performed in the same manner as for the 300 KIAS check except that the angle of bank should not be allowed to exceed 30 degrees. Prior to conducting a rate of roll check at an airspeed less than 300 KIAS, the pilot must reduce the nose pitch down tendency with elevator trim in order to obtain an accurate rate of roll. Although not as desirable as if performed at 300 KIAS, this rate-of-roll check will enable ground personnel to make an initial corrective adjustment. When an excessive rate of roll or pitch condition develops at an airspeed of less than 300 KIAS and the pilot believes that the aircraft may become uncontrollable at a higher airspeed, no further attempt shall be made to perform the rate of roll check at a higher airspeed. If the aircraft becomes uncontrollable after a disconnect at 200 KIAS, an emergency situation exists and the check is to be terminated. Trim should be used immediately in an attempt to stop the roll and regain control of the aircraft and the throttle retarded to idle to reduce airspeed. After the rate of roll has been recorded, the aircraft should be "slow-flighted" in the landing configuration and retrimmed as necessary for a safe landing. Speeds in excess of 200 KIAS should be avoided for the remainder of the flight.

Aircraft Nose Pitch Tendencies

On disconnect at 200 KIAS with the aircraft trimmed for 300 KIAS, the aircraft will tend to pitch nose down and seek the 300 KIAS trim setting. As the airspeed following disconnect is increased, the nose-down pitching tendency will normally decrease. At 300 KIAS, the aircraft may exhibit either a slight nose-up or slight nose-down pitching tendency. A slight nose pitching tendency (either up or down) has no effect on the resulting rate of roll. If excessive, a nose-down pitch will result in increasing airspeed which will in turn accentuate the roll rate of the aircraft.

WARNING

An excessive nose-down pitch if not corrected will result in an increased airspeed and an accentuated rate of roll. If allowed to progress and/or if airspeed is allowed to build up to over 325 knots, control of the aircraft may be lost. Do not allow the aircraft to exceed 15 degrees nose low.

CAUTION

In the event of excessive nosedown pitch, use of speedbrakes may cause an increased nose-down tendency because of the elevator/speed brake interconnect.

NOTE

Although no limit has been established for the nose-down or nose-up pitching movement, a 1 degree per second nose pitchup or pitchdown rate is generally acceptable. If nose pitch-up or pitch-down is greater than 1 degree per second, the direction of the rate of pitch should be noted and recorded so that maintenance personnel may take corrective action.

Use Of Rudder In Controlling Rolling Moment

Momentary use of the rudder to control or stop a rolling moment is optional. However, when rudder is utilized to correct a rolling moment, the resulting rate of roll is suspect. The preferred method is to stop the rate of roll with the ailerons. If heavy stick forces are present, conduct the rate-of-roll check at an airspeed slower than 300 KIAS.

WARNING

Extensive use of the rudder, either to maintain level flight or to stop a roll, may result in asymmetric wing fuel loading. Asymmetric loading of the wings will accentuate the rate of roll at disconnect and may result in an excessive rate of roll.

- f. Accelerate to 300 KIAS. Under normal circumstances, the rate-of-roll check should be performed at 300 KIAS since the aircraft as trimmed in hands-off, straight and level flight at this airspeed. Use of the trim systems should be avoided while accelerating in straight and level flight to 300 KIAS since this will destroy the conditions required for a proper rate-of-roll check. However, if the control forces in either roll or pitch become so severe during acceleration that continued control of the aircraft becomes doubtful, the rate-of-roll check is to be discontinued immediately or performed at a slower airspeed (as previously discussed).
- g. At 300 KIAS, record the rate of roll. When stabilized wings level at 300 KIAS, time the rate of roll using the elapsed time clock and the ADI.

WARNING

Do not allow the aircraft to exceed 60 degrees of bank. An angle of bank in excess of 60 degrees may allow the nose of the aircraft to fall through, which will in turn cause the angle of bank to increase rapidly. In this situation, an excessive rate of roll may develop and cause the aircraft to become uncontrollable before corrective action can be taken.

AL 8 (0)

After timing the rate of roll, return the aircraft to the wings-level attitude without use of trim (if possible). An error in timing may have occurred during the initial timing attempt since five degrees per second (the maximum allowable rate-of-roll) is very slow. Repeat the check to ensure an accurate rate of roll is recorded.

- h. Retrim for hands-off, straight and level flight at 300 KIAS. After determining the direction and rate of roll, the aircraft should be returned to straight and level flight, and retrimmed to maintain that condition.
- i. After the aircraft has been retrimmed at 300 KIAS, note and record the deflection angle of the followup tab with the aileron. Then decelerate and perform a simulated landing approach using all systems that may be required during an actual landing (speedbrakes, landing gear, flaps) to determine any adverse effects which they might have on control of the aircraft.
- j. Prior to landing, place the stability augmentation switch on the AFCS control panel to STAB AUG and the spoiler switch to ARM.
- k. Upon completion of the flight, entries are to be made in the Form 700 that the flight control hydraulic power system was disconnected, the resultant direction and rate of roll, and any adverse flight conditions which resulted from the disconnect. This information and any pertinent remarks which would aid other pilots or maintenance personnel in the future should also be entered in the functional test flight checklist record which is then retained in the aircraft maintenance files.

NOTE

Safety is of primary importance throughout the entire hydraulic power disconnect check. If aileron trim is required immediately after disconnect for any reason or if any condition is present which may result in an excessive rate of roll, the pilot should not hesitate to use trim and is to terminate the hydraulic power disconnect check.

Landing Considerations And Aircraft Handling

While operating with manual flight controls, aircraft flight control response is markedly reduced. However, the use of trim and coordinated turns will result in an easily controllable aircraft. Because of the reduced lateral response and the delay in response following flight control inputs, a slightly faster approach to landing is recommended.

AB

74. Low Fuel Level Warning – CHECK

Light should come on at approximately 1,100 pounds fuel remaining with aircraft in level flight attitude.

Landing

If in manual disconnect, make a straight-in approach.

ABC

75. Pre-landing checks – COMPLETE

A

76. Brake operation – CHECK

A

77. Ground Handling – CHECK

AL 8(7)

After Landing

- ABC
78. After landing Checks – COMPLETE
- For a rework or acceptance test flight, do not cage the ADI. (See Item 85)
- A
79. ADI Attitude captions – RECORD
- Caption should not appear during flight. Record the number of occurrences.
- A
80. Oxygen Consumption – CHECK
- AB
81. Engine Oil Quantity – CHECK
- A
82. INU Accuracy – RECORD
- a. Radial Error Rate.
- b. Time in Nav mode.
- c. INU CEP.
- d. Drift for flight.
83. Clock Accuracy – CHECK
- Accuracy of normal and elapsed time functions.
- AB
84. Secure engine from IDLE RPM using MANUAL FUEL SHUTOFF. Record time from operating MANUAL FUEL SHUTOFF to actual engine shut down (approximately 15 to 30 seconds).

NOTE

Shut down should be initiated by using the manual fuel shutoff. As the engine unwinds through idle, the throttle should be brought to OFF to prevent possible cavitation of fuel pump and lines.

- A
85. Attitude Direction Indicator – CHECK
- Upon engine shut down, ADI should remain erect (± 6 degrees) for greater than 3 minutes. This will require that the ADI is not caged during the after landing checks.
- A
86. System Boresighting – CHECK
- Approximate indication can be gained by verifying INU generated horizon bars compared with horizon and if possible obtaining either a MARITIME or AIR TARGET lock and confirming radar HUD symbology overlays target.

AL 5(0)

CHAPTER 7

NAVIGATION/ATTACK SYSTEM

PAGE	PAGE
SYSTEM CONTROLS AND DISPLAYS	7-1
INTRODUCTION	7-1
COMPUTER INTERFACE UNIT	7-1
DISPLAY PROCESSOR	7-1
SYSTEM RELAY BOX	7-1
NAS POWER PANEL	7-2
NAS PANEL	7-2
NAS CONTROL TRANSFER SWITCH	7-2
CONTROL TRANSFER RELAY BOX	7-3
Throttle	7-3
Control Stick	7-3
NAV Panel	7-3
NAS Panel	7-3
UFC	7-3
DUs	7-3
NAV PANEL	7-3
HEAD UP DISPLAY	7-3
Introduction	7-3
HUD Controls	7-3
HUD Symbology	7-5
Air Speed	7-5
Mach Number	7-5
Commanded Airspeed	7-5
Heading	7-5
Track Angle Error Steering	7-5
Angle Of Attack	7-6
Pressure Altitude	7-6
Radar Altitude	7-6
Normal Acceleration	7-6
Vertical Speed	7-7
Fuselage Reference Line (FRL)	7-7
Armament Datum Line (ADL)	7-7
Flight Path Marker (FPM)	7-7
Velocity Vector (VV)	7-7
Pitch Bars	7-7
-3 Degree Pitch Bar	7-8
Zenith and Nadir	7-8
Horizontal Situation Indicator (HSI)	7-8
Destination	7-9
Markpoint	7-9
ILS Display	7-9
Weapon Aiming Symbology	7-10
Initiated Built In Test Indication	7-10
Scratchpad	7-10
HUD Symbology Declutter	7-10
HUD Symbology Occlusion	7-10
Data Windows	7-10
Data Windows During Alignment or Test	7-10
Data Windows in NAV	
Master Mode or Ground	7-10
Data Window Parameter Definitions	7-10
UP FRONT CONTROLLER	7-12
Numeric Entry Error Handling	7-12
UFC Keys	7-12
Page Access Keys	7-12
Data Entry Keys	7-14
Miscellaneous Keys	7-14
COCKPIT TELEVISION SENSOR	7-15
HUD POWER SUPPLY	7-15
HUD SWITCH	7-15
DISPLAY UNIT	7-15
Peripheral Keys	7-15
Index Key	7-15
Select Key	7-15
DU Display Types	7-16
Display Processor Generated Text	7-16
Multiple Page Indices	7-16
Data Entry	7-16
Failure Indication	7-16
Brightness and Contrast Controls	7-18
Day/Night/Off Switch	7-18
Radar Symbol Brightness Control	7-19
DATA TRANSFER SYSTEM	7-19
GENERAL	7-19
LOADING	7-19
UNLOADING	7-19
AIRBORNE VIDEO TAPE RECORDER	7-20
DESCRIPTION	7-20
OPERATING MODES	7-20
Run Mode	7-20
Auto Mode	7-20
CONTROLS AND INDICATIONS	7-20
Mode Switch	7-20
VIEW Pushbutton	7-20
NAS Controls and Indicators	7-20
BUILT IN TEST	7-22
INTRODUCTION	7-22
ANNUNCIATION OF FAULTS	7-22
PILOT'S FAULT LIST	7-22
HUD FAILURE	
ANNUNCIATION: ATTITUDE	7-22
NAS INITIATED BIT	7-23
RADAR INITIATED BIT	7-24
AFCS INITIATED BIT	7-24
AFCS Test 1	7-24
AFCS Test 2	7-24
INERTIAL NAVIGATION UNIT	7-25
INTRODUCTION	7-25
INU CONTROLS	7-25
INU ALIGNMENT	7-25
Alignment Types	7-25
Alignment Scratchpad Display	7-25
Alignment Data Windows	7-25

CHAPTER 7 Cont.

NAVIGATION/ATTACK SYSTEM

	PAGE		PAGE
NORMAL OPERATION	7-27	Acquisition Window & Tracking Gate Sel.	7-42
POSITION UPDATING	7-27	Symbology Intensity Control	7-42
Overfly Update	7-28	Raster Symbology Brilliance Control	7-42
HUD Updating	7-28	Radar/Fix Switch	7-42
Radar Updating	7-28	Designate Function	7-43
Navaid Updating	7-28	Return to Search	7-43
RADIAL ERROR RATE CALCULATION	7-28	Radar Mode	7-44
SYSTEM ALTITUDE	7-29	Slew Control	7-44
COMMUNICATIONS	7-30	Antenna Elevation Control	7-44
INTRODUCTION	7-30	Radar Gain Controls	7-44
AN/ARC-182 UHF/VHF	7-30	RADAR DISPLAYS	7-44
Frequency Selection	7-30	RADAR MODES	7-48
Mode Control	7-31	Standby	7-48
ARC-159 UHF	7-31	AIR-TO-AIR MODES	7-48
Controls and Indicators	7-31	Air Search	7-48
VIR-130 COMM MODE	7-33	Acquisition	7-48
INTERCOM SYSTEM	7-33	Single Target Track	7-49
AUDIO PANEL	7-33	Situation Awareness Mode	7-49
SECURE VOICE EQUIPMENT	7-34	Air Combat Mode	7-50
General Description	7-34	ACM SCAN PATTERNS	7-50
Controls and Indicators	7-34a	HUDACQ	7-50
NAVAIDS	7-35	VERTACQ	7-50
INTRODUCTION	7-35	Boresight	7-50
Paired Tuning	7-35	Sleuable ACM	7-50
AN/ARN-118(V) TACAN	7-35	AIR-TO-GROUND MODES	7-52
Operating Modes	7-35	Ground Map	7-52
TACAN Panel Control	7-36	Doppler Beam Sharpening	7-53
NAS Control	7-36	Beacon	7-53
VIR-130 VOR/ILS	7-36	Air-to-Ground Ranging	7-53
Control	7-37	SEA Modes	7-54
VOR Reception	7-37	Maritime Target Track	7-57
ILS Reception	7-37	NAVIGATION	7-59
Marker Beacon Reception	7-37	INTRODUCTION	7-59
DME Hold	7-37	NAS NAVIGATION	7-59
AN/ARA-50 AUTOMATIC		Navigation Data Base	7-59
DIRECTION FINDER	7-38	Waypoints	7-59
APG-66 (NZ) RADAR	7-39	Pop Codes	7-59
INTRODUCTION	7-39	Navaid Points	7-63
RADAR CONTROLS	7-39	Mark Points	7-63
Radar Control Panel	7-39	Overfly Mark	7-63
Mode Control	7-39	HUD Mark	7-63
Range Scale	7-40	Radar Mark	7-64
Pulse Repetition Frequency	7-40	Designated Target Marking	7-64
Azimuth Scan	7-40	Reviewing And Altering Nav Data	7-64
Elevation Bar	7-41	Destination Selection	7-65
Target History	7-41	Course Selection	7-65
Freeze	7-41	Warning of Approaching a Destination	7-66
Altitude Line Tracker/Blanker	7-41	Steering Information Beyond The Destination	7-66
Channel Select	7-41	Desired Time Of Arrival	7-66
Marker Intensity	7-42	NAVAID NAVIGATION	7-66
Moving Target Rejection	7-42		

AL 8(5)

CHAPTER 7 Cont. NAVIGATION/ATTACK SYSTEM

PAGE	PAGE
OFFSET NAVAID NAVIGATION	7-66
HUD APPROACH MODE	7-67
STEERING AND GUIDANCE INFORMATION	7-67

FIGURES

FIGURE	PAGE	FIGURE	PAGE
7-1 NAS Power Panel	7-2	7-19 Air-to-Air Mode Scales	7-45
7-2 NAS Panel	7-2	7-20 Air-to-Air Display Unit Symbology	7-46
7-3 NAS Control Transfer Switch	7-2	7-21 Air-to-Ground Display Unit Symbology	7-47
7-4 NAV Panel	7-3	7-22 Standby Mode Format	7-48
7-5 UFC Keyboard /HUD Brightness Control	7-4	7-23 Air To Air Radar Mode Selection	7-49
7-6 Destination Symbol Display Criteria	7-9	7-24 ACM Scan Patterns	7-50
7-7 Display Unit	7-15	7-25 ACM Scan Patterns	7-51
7-8 DU Display Pages	7-17	7-26 Typical Ground Map (GM) Display	7-52
7-9 AVTR Record Modes	7-21	7-27 Typical Expand Operation	7-52
7-10 Sample Pilot Fault List Scratchpad Display	7-22	7-28 Ground Map Submodes	7-53
7-11 INU Scratchpad Indications During INU Alignment	7-26	7-29 Typical Freeze Display	7-53
7-11a System Altitude Derivation	7-29	7-30 Typical Air-to-Ground Ranging (AGR) Display	7-54
7-12 ARC-182 Frequency Bands	7-30	7-31 SEA 1 Mode Display	7-54
7-13 ARC-159 Control Panel	7-31	7-32 Expanded x2 SEA 1 Submode	7-55
7-14 Audio Panel	7-33	7-33 Gain Adjustment For Target Detection	7-56
7-14a KY-58 Remote Control Unit	7-34a	7-34 SEA 1 & SEA 2 Submode Selection	7-57
7-14b KY-58 Programmer	7-34a	7-35 Typical MTT Frozen Map Display	7-58
7-15 TACAN Panel	7-35	7-36 NAS Steering Examples – Planned Course	7-67
7-16 Radar Control Panel	7-39	7-37 NAS Steering Examples – Fixed Course	7-68
7-17 Antenna Elevation Scan Patterns In Air Search	7-41	7-38 NAS Steering Example – Direct Course	7-68
7-18 Sea Mode Return to Search/Designate Flow Chart	7-44		

NZAP 6213.005-1

AL 8(0)

TABLES

TABLE		PAGE	TABLE		PAGE
7-1	HUD Power Control	7-4	7-14	ARC-159 Controls and Indicators	7-32
7-2	HUD Brilliance Controls	7-4	7-15	Audio Panel Controls	7-34
7-3	Data Windows in NAV Master Mode	7-11	7-15a	KY-58 RCU Controls and Indicators	7-34a
7-4	Data Window Parameters (Navigation Mode)	7-11	7-15b	KY-58 Programmer Controls and Indicators	7-34b
7-5	UFC Page Access Keys	7-12	7-15c	KY-58 Aural Tones	7-34b
7-6	UFC Data Entry Keys	7-14	7-16	TACAN Mode Operation	7-36
7-7	UFC Miscellaneous Keys	7-14	7-17	VOR Information and Display	7-37
7-8	HUD Switch Functions	7-15	7-18	ILS Information and Display	7-37
7-9	AVTR Mode Operation.	7-22	7-19	Radar Mode Selection	7-40
7-10	I-BIT Test Display	7-23	7-20	Antenna Scan Coverage	7-41
7-11	INU Controls	7-25	7-21	Designate Switch Functions	7-43
7-12	INU Scratchpad Indications During INU Alignment	7-26	7-22	Navigation Indications In Navigation Master Mode	7-61
7-13	AN/ARC-182 Operating Parameters	7-31	7-23	Toggle Entry Parameters	7-65

CHAPTER 7

NAVIGATION/ATTACK SYSTEM

SYSTEM CONTROLS AND DISPLAYS

INTRODUCTION

7.1 The Navigation/Attack System is a self contained, integrated navigation and weapon aiming system. It obtains and processes inertial and air data information to solve the navigation problem and co-ordinate air-to-air and air-to-ground weapon delivery. The major components of the NAS are shown in block diagram form in Foldout 4.

COMPUTER INTERFACE UNIT

7.2 The NAS is based on a Computer Interface Unit which is a general purpose, stored program, programmable, real time, digital computer with a 16 bit instruction word size and two Mil Spec 1750 processors. The CIU performs the following functions:

- a. Acts as the primary bus controller for the 1553B multiplex data bus.
- b. Provides for NAS mode control and option select for various avionic and weapon systems.
- c. Uses input data to compute and generate missile launch and weapon release commands.
- d. Controls tuning of the ARC-182, VIR-130, and ARN-118.
- e. Outputs BIT initiated signals to various avionic systems, and receives avionics systems BIT status signals for the output of advisory and caution displays on the HUD and DU.
- f. Uses input data from the INU, DADC, TACAN, and VOR/ILS for navigation and steering command computation.
- g. Generates and controls all display symbology on the HUD.
- h. Generates and controls symbology for overlay onto the radar display.
- i. Uploads and downloads data to/from the DTM.

DISPLAY PROCESSOR

7.3 The Display Processor is a general purpose, stored program, programmable, real time, digital computer with a 16-bit instruction word size and contains a single Mil Spec 1750 processor. It performs the following functions:

- a. Acts as the backup bus controller for the 1553B multiplex data bus.
- b. Generates and controls all text displays on the DU.
- c. Uses input data from the INU, DADC, TACAN, and VOR/ILS for navigation and steering command computation in the event of CIU failure.
- d. Controls DU video switching and video source selection to the AVTR.
- e. Controls tuning of the ARC-182 and VIR-130.

SYSTEM RELAY BOX

7.4 The System Relay Box interconnects and redirects signals between various units in the NAS as follows:

- a. Distributes 'magnetic heading' from the CIU and INU, to the TACAN, VOR/ILS, RWS, and HSI.
- b. Distributes 'relative bearing' from the NAS, TACAN, VOR/ILS and ADF, to the HSI.
- c. Distributes 'selected course' from the HSI, to the NAS, TACAN, and VOR/ILS, and determines the active HSI in the TA-4 in conjunction with the NAS Control Transfer Switch.
- d. Distributes 'course deviation' and TO/FROM flag signals from the NAS, TACAN, and VOR/ILS to the HSI.
- e. Distributes 'distance' from the NAS and TACAN to the HSI.
- f. Distributes steering commands from the NAS to the ADI and HSI.
- g. Distributes localizer and glideslope deviation from the VOR/ILS to the HSI and ADI.

- h. Generates and distributes parking voltages for the HSI compass card and ADI pointers when no valid data is available.
- i. Controls the operation of the Master Caution Light.
- j. Controls the AVTR mode lights on the NAS Panel.
- k. Relays CIU BIT initiation to the Radar Altimeter.
- l. Distributes and regulates the alternate slew excitation voltage from the APG-66 when the normal 15 VDC power supply fails.

NAS POWER PANEL

7.5 The NAS power panel (Figure 7-1), located on the left console, controls the power to the CIU, DP, INU, and DADC. Its function is to remove power from individual components of the system in the event of a component failure.

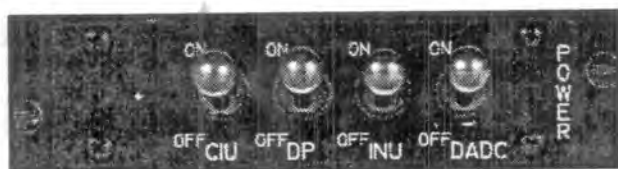


Figure 7-1 NAS Power Panel

NAS PANEL

7.6 The NAS panel (Figure 7-2), located on the right console, performs the following functions:

- a. Through the INU Switch, controls power to the NAS, specifically the CIU, DP, INU, DADC, 15 VDC power supply, and in the TA-4, the 5 VDC power supply; controls the INU alignment and navigation mode; controls INU initiated BIT.
- b. Through the RADAR Switch, controls the radar receiver coarse gain, and
- c. Through the pushbutton lights, controls the AVTR mode.



Figure 7-2 NAS Panel

TA-4 AIRCRAFT ONLY

NAS CONTROL TRANSFER SWITCH

7.7 The NAS control transfer switches (Figure 7-3), located on the main instrument panel of each cockpit above the fuel flow indicator, are used to transfer NAS control functions from the front seat to the rear seat and vice versa. The transfer function is accomplished by the control transfer relay box. The functions that are transferred are described in paragraph 7.8.

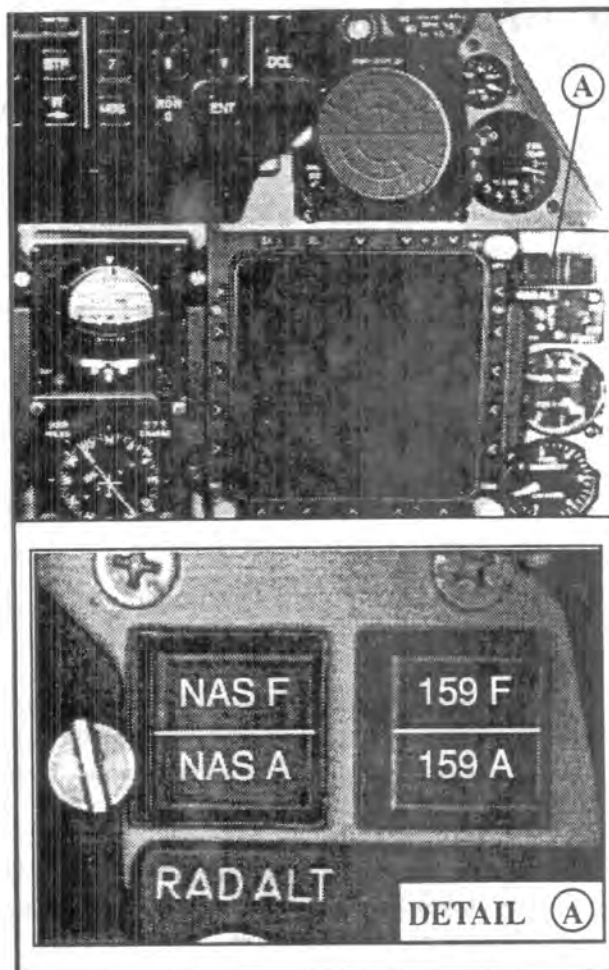


Figure 7-3 NAS Control Transfer Switch

CONTROL TRANSFER RELAY BOX

7.8 The Control Transfer Relay Box operates in conjunction with the NAS Control Transfer Switch and transfers the following control between cockpits:

Throttle

- Master Mode Switch
- Slew Control Switch
- Antenna Elevation Control
- Undesignate Switch
- Radar Gain Control/Missile Step Switch
- Uncage Switch
- Program Change Switch

Control Stick

- Gun/Missile Trigger
- Pickle Button
- Radar/Fix Switch

NAV Panel

- Course Switch
- Reference Switch
- DME Hold Switch

NAS Panel

- Radar Receiver Gain Control

UFC

- All UFC Keys

NOTE

The BIT light is active in both cockpits. However, only the active cockpit can acknowledge the fault.

DUs

- All Soft Keys
- INDEX Key

NAV PANEL

7.9 The NAV panel (Figure 7-4) located on the right console, provides selection of the desired reference source, selection of the course type and selection of the DME hold facility.



Figure 7-4 NAV Panel

HEAD UP DISPLAY

Introduction

7.10 A 24-degree total field of view HUD (Figure 7-5) superimposes attitude, navigation, and weapon aiming information on the outside world. The HUD is capable of displaying both stroke or raster symbology. The raster capability is not currently used.

HUD Controls

7.11 Power is controlled by the HUD/OFF/STBY control located on the main instrument panel. The switch functions are shown in Table 7-1.

7.12 Symbology brilliance control is provided by rotary switches located on the side of the HUD. Switch functions are shown in Table 7-2.

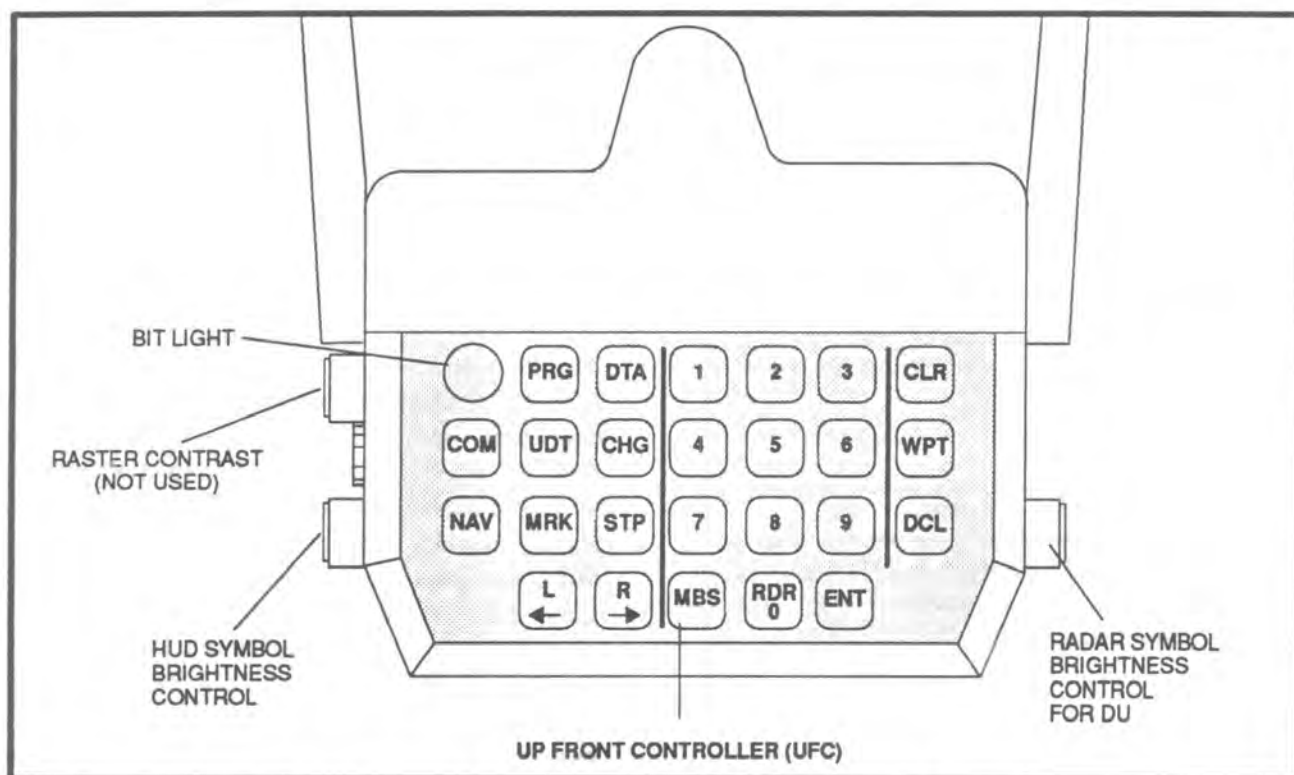
7.13 The HUD system incorporates an autobrilliance function which is selected from the UFC data menu, and the day/night/off (D/N/OFF) switch on the right DU. When the D/N/OFF switch is set to the **D** position and autobrilliance scratchpad display is ON, the contrast between the forward looking outside view and the HUD symbology is maintained. Thus, as the forward looking view changes in intensity the HUD symbology brightness is automatically adjusted to maintain a constant contrast. The contrast level can be adjusted at any time using the HUD symbol brightness control. Brightness of the forward view is measured by a forward looking light sensor mounted in the HUD. The autobrilliance function is selected OFF if the right DU is selected to N. At NAS power on, with the right DU selected to **D**, autobrilliance default is ON.

Table 7-1 HUD Power Control

SWITCH	FUNCTION
HUD	Switches the HUD LVPS on. The LVPS supplies power to the HUD and CTVS.
OFF	Removes power from the LVPS.
STBY	Switches 28 VDC power to the standby sight and switches power from the 15 VDC power supply to the CTVS.

Table 7-2 HUD Brilliance Controls

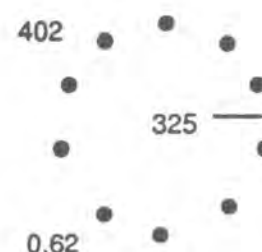
CONTROL	POSITION	FUNCTION
HUD Symbol Brightness	Left Lower	The HUD symbol brightness control adjusts all HUD symbology and, when displayed, adjusts the brightness of the standby sight reticle.
Raster Contrast	Left Upper	Not used.
Radar Symbol Brightness	Right	The radar symbol brightness control adjusts the CIU-generated symbology displayed with the radar video on the display unit.

**Figure 7-5 UFC Keyboard /HUD Brightness Control**

HUD Symbolology

Air Speed

7.14 Pitot-static derived airspeed is displayed in the upper left of the HUD FOV. The current indicated airspeed is displayed numerically in the centre of the dial. The two least significant digits are also indicated by a pointer on the dial. The minimum value displayed is 50 KIAS.



Mach Number

7.15 The current mach number, if between 0.5 and 1.3 IMN (Indicated Mach Number), is displayed beneath and to the left of the airspeed dial.

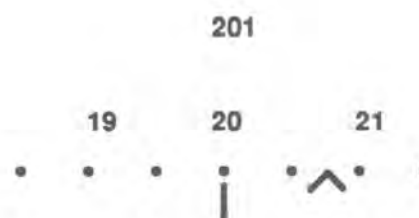
Commanded Airspeed

a. *Error greater than 40 KIAS.* When the difference between the current airspeed and the commanded airspeed is greater than 40 KIAS, the commanded airspeed is displayed above and to the left of the airspeed symbol. Commanded airspeed will flash at values greater than 540 KIAS, and is limited to 620 KIAS.

b. *Error less than 40 KIAS.* When the difference is less than 40 KIAS, a commanded airspeed caret is displayed on the outside of the airspeed dial.

Heading

7.16 Inertially derived aircraft magnetic heading is displayed at the top of the HUD FOV in all modes except air-to-air missile, in which case it is displayed at the bottom of the HUD FOV. The display uses a fixed pointer (lubber line) on a graduated moving heading scale with the current magnetic heading displayed numerically above the heading scale.



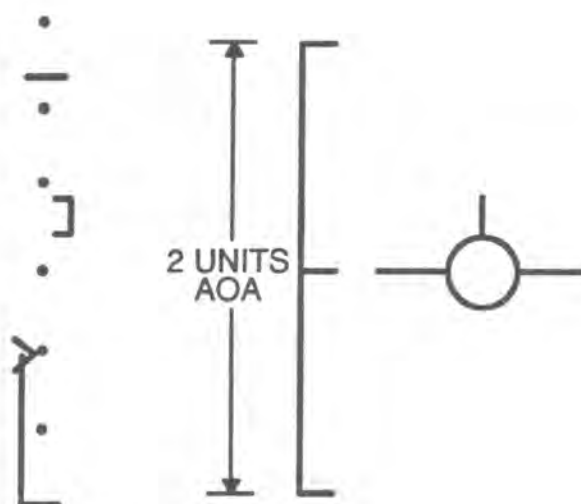
Track Angle Error Steering

7.17 Track Angle Error steering is displayed on the heading scale relative to the lubber line. The magnitude of its displacement represents the Track Angle Error and the direction to steer in order to null command. AFCS NAS steering is shown as a double TAE caret.

Angle Of Attack

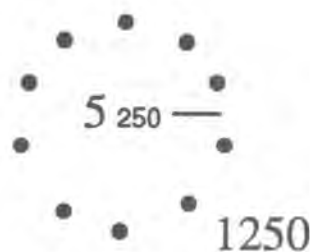
7.18 DADC derived indicated angle of attack is displayed on a vertical tape scale on the left side of the HUD FOV. The AOA scale has a range of 0 to 30 units, and is graduated every 5 units. A line extending from zero with a caret at its end indicates the current AOA. Optimum angle of attack is indicated by an open bracket ([]) on the right side of the scale. The optimum angle of attack values are 17.5 units (A-4) and 16.5 units (TA-4). Stall angle of attack is indicated by a line placed at 27 units. Digital G is displayed next to the AOA caret in the Approach mode.

7.19 In the Approach mode, the AOA display is augmented with an optimum AOA bracket which is on the left of, and referenced to the FPM. The symbol subtends two units centred about the tick mark at the optimum AOA. With the FPM at the top of the scale the aircraft is 1 unit above optimum, and is 1 unit below optimum when at the bottom of the scale.



Pressure Altitude

7.20 Pressure altitude corrected for the inserted value of barometric pressure is displayed in the upper right of the HUD FOV. The current altitude is displayed numerically in the centre of a dial, with a resolution of ten feet. The three least significant digits are also indicated by a pointer on the dial. Values below sea level (down to 990 feet below sea level) are prefixed by a flashing minus sign.

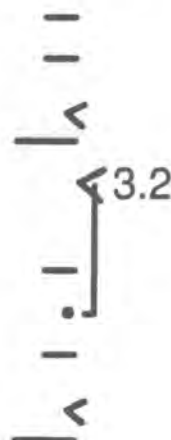


Radar Altitude

7.21 Radar Altitude is displayed below the pressure altitude in the upper right of the HUD FOV. If the Radar Altimeter is OFF, the signal invalid, the BIT fails, or the radar altitude is greater than 5000 feet, the display is blanked. When the radar altitude is below the inserted LAWS value, the display will flash.

Normal Acceleration

7.22 Normal acceleration is displayed on a G scale at the right side of the HUD FOV. The G scale consists of a vertical tape scale having a range between 7 and -3 g. Bars are positioned at -3, -1, 1, 4, 6, and 7 g. A line extending from the zero index, with a caret at its end indicates the current value of the normal acceleration. A numeric G value is also displayed adjacent to the caret.

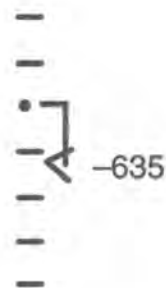


7.23 Maximum and minimum G encountered are shown on the scale as small carets. When the current maximum or minimum value is being exceeded, the small carets are repositioned to reflect the new max/min G. It is possible to reset the displayed indications of maximum and minimum G levels via the data menu page on the HUD scratchpad. In the Approach mode the G Scale is replaced by the Vertical Speed scale.

AL 9(0)

Vertical Speed

7.24 Vertical speed replaces normal acceleration on the right hand side of the HUD FOV in the Approach mode only, and ranges between +1000 and -4000 fpm. The display of the scale is piece-wise linear, with bars positioned at +1000, +500, -500, -1000, -2000, and -4000 fpm. A vertical thermometer and caret originating at the zero index represent the value of the vertical speed. A digital readout of vertical speed is presented next to the caret.

*Fuselage Reference Line (FRL)*

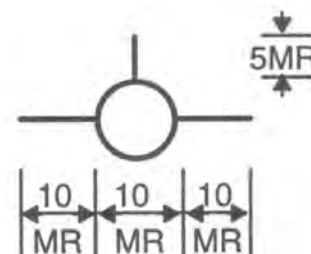
7.25 When the landing gear is selected down, the FRL symbol is positioned on the Fuselage Reference Line.

*Armament Datum Line (ADL)*

7.26 When the landing gear is selected up the ADL symbol, a boresight cross, is positioned on the ADL. If the Air to Air Missile mode is selected the cross is replaced by a 1 milliradian dot. The ADL is one degree below the FRL.

*Flight Path Marker (FPM)*

7.27 The FPM is used to represent the aircraft in the HUD. In the Nav and A/A Master Modes, the symbol is fixed to the centreline and is referenced to the pitch bars to show aircraft flightpath angle.

**NOTE**

At 60 degrees angle of bank the FPM quickening algorithms change, and if aircraft drift is present the FPM will be observed to "jump". The magnitude of the "jump" is correlated positively to drift. The VV will continue to show actual flight path angle.

Velocity Vector (VV)

7.28 The VV symbol is a quarter scale FPM that is free to move in azimuth, the magnitude of which represents the aircraft drift angle. The VV is not displayed when drift is less than 22 milliradians.

NOTE

Both the FPM and the VV are 'quickened'. This involves applying a term proportional to the aircraft body axis pitch rate to maintain the symbols near the FRL during hard manoeuvring. The symbols would otherwise disappear off the bottom of the HUD FOV during high pitch rates.

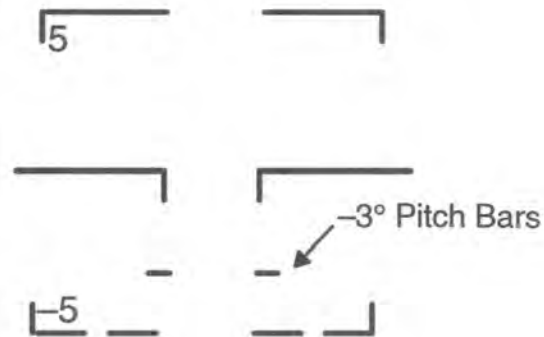
AL 9(0)

Pitch Bars

7.29 Pitch bars are shown every 5 degrees as solid lines above the horizon, dotted lines below the horizon, and a solid double line on the horizon. All pitch bars with the exception of the Horizon Line have horizon pointing ticks on their outboard edges and pitch values on the left hand side, nearest the horizon. The Horizon Line has earth pointing ticks on the inboard edge, and is positioned on the horizon by the INU.

NOTE

As altitude increases, the Horizon Line will be shown progressively higher than the horizon due to curvature of the earth.

*-3 Degree Pitch Bar*

7.30 In the NAV Master Mode, with airspeed less than 250 KIAS or in Approach mode, a -3 degree pitch bar is displayed in order to assist establishing a 3 degree glidepath.

*Zenith and Nadir*

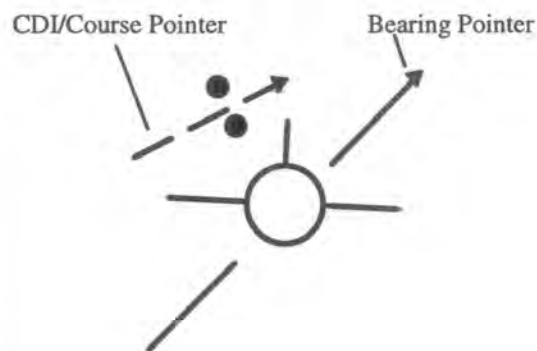
7.31 The line in the zenith (up) and nadir (down) symbols points to the nearest horizon.

Horizontal Situation Indicator (HSI)

7.32 The HSI bearing pointer, course deviation indicator (CDI), and course pointer, are displayed in the HUD centred around the FPM, with the CDI and the course pointer being combined into a single symbol.

7.33 The bearing pointer is two line segments one each side of the FPM, with an arrowhead on one end. It points in the direction of the destination relative to the heading of the aircraft. The symbol set is roll stabilized, i.e. the bearing pointer always points to the destination irrespective of aircraft bank.

7.34 The CDI/Course pointer is a dashed line which is displaced relative to the FPM. To provide displacement scaling reference, a set of dots is displayed, against which the magnitude of the deviation can be measured. The angular orientation of the CDI/Course pointer represents the fixed course, set on the HSI, relative to the current heading, with the arrowhead in the direction of the course.



AL 9(0)

7.35 A course deviation scale comprising two dots is displayed on the same side of the FPM as the CDI. Each dot represents 2 nautical miles (NAS reference, planned or fixed course) or 5 degrees (NAVAID and OFFSET NAVAID reference) of deviation from the desired course. The dots are positioned on the line through the centre of the FPM and perpendicular to the CDI. When the magnitude of the course deviation is less than half of the maximum deviation, one dot is placed on each side of the FPM. In direct course there is never any course deviation and the CDI is removed from the display.

Destination

7.36 The computed steer-to-destination is displayed whenever the distance/altitude criteria as shown in Figure 7-6 is met, or during an update. Waypoint (W), Navaid (N) and Mark (M) points, and tuned Nav aids are shown as a solid square of 10 milliradian sides with a one milliradian centre dot. An I point is displayed with the addition of a short line segment attached to the centre of each side of the square; and an O point is a dashed version of the same symbol. If the destination is either an I point or an O point of an I/O point pair, both of the points are displayed. When the location of the destination falls outside the HUD FOV, an X is superimposed over the symbol.

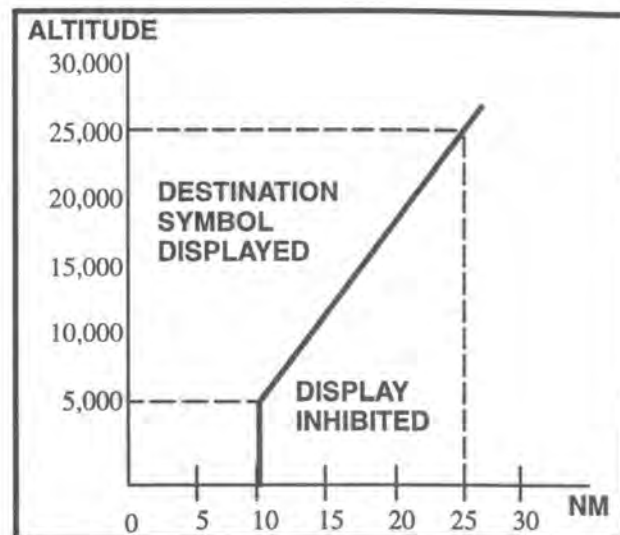
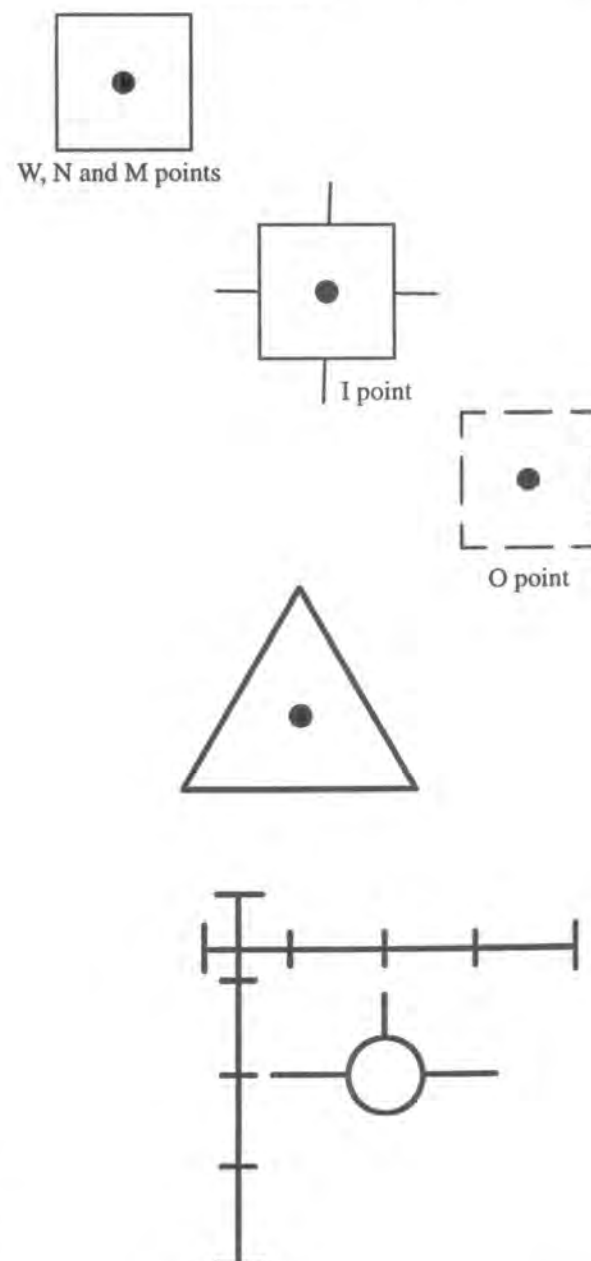


Figure 7-6 Destination Symbol Display Criteria



Markpoint

7.37 The markpoint symbol is used to show the position to be marked. When the location of the Mark point falls outside the HUD FOV, an X is superimposed over the symbol.

ILS Display

7.38 Localizer and Glideslope deviation bars are displayed relative to the FPM which is the zero reference point for the appropriate deviation. The tick marks show full and half scale deflections. The ILS presentation is raw data only. TAE steering is not provided with the ILS bars.

Weapon Aiming Symbolology

7.39 HUD symbolology applicable to weapon delivery is shown in Chapter 8.

Initiated Built In Test Indication

7.40 The word "TEST" is displayed at the centre of the HUD FOV whenever NAS Initiated BIT is active.

Scratchpad

7.41 The HUD scratchpad is an area which consists of 4 lines by 31 characters and is located in the lower centre of the HUD FOV. The area is used for review and entry of data and is controlled through the Up Front Controller. It is only displayed when called up as a result of pressing one of the UFC page access keys. When displayed, the scratchpad occludes all other symbols except during a mark or update.

HUD Symbolology Declutter

7.42 The HUD has three levels of symbolology declutter and the pilot has the ability to change between levels using the UFC Declutter Key, labelled DCL. Successive strokes of the DCL key will cycle the symbolology suite through the levels i.e. 1, 2, 3, 1, 2.... Whenever the Master Mode is changed, the new mode is presented in the same DCL level as the previous mode.

7.43 The DCL 2 level removes the following from DCL 1:

- a. Bearing Pointer
- b. CDI Bar
- c. Digital Heading

7.44 The DCL 3 level removes the following from DCL 2:

- a. Pitch Bars except -3 degree pitch bar
- b. Fuselage Reference Line
- c. Armament Datum Line

HUD Symbolology Occlusion

7.45 Some HUD symbols will be occluded (i.e. hidden) by others due to the windowing effect associated with "protected" symbols and the order in which the symbols are

drawn. For example, the Scratchpad will take precedence over other symbols except when Marking or Updating.

Data Windows

7.46 Textual flight data is presented to the pilot via eight HUD Data Windows which are located four each side of the HUD in the lower left and right hand corners of the FOV. Data is refreshed every 0.5 seconds. Each Data Window consists of 4 lines, with a maximum of 8 characters per line and are defined as L1-4 and R1-4, with L1 being the top left hand line, L2 being the second left hand line etc. The information displayed in each data window is dependant upon the active mode and submode as described in the following paragraphs.

Data Windows During Alignment or Test

7.47 With the NAS Panel INU switch in the ALIGN or TEST positions, the following data is displayed in the left and right hand data windows.

L1	(blank)	R1	ALIGN TYPE
L2	(blank)	R2	ALIGN STATUS
L3	(blank)	R3	ALIGN ACCURACY
L4	TIME OF DAY	R4	TIME IN ALIGN

Data Windows in NAV Master Mode or Ground

7.48 With NAV selected on both the NAS Panel INU switch and Master Mode Switch, or with GND selected on the NAS Panel INU switch, the following data is displayed in the data windows.

L1	See Table 7-3	R1	See Table 7-3
L2	See Table 7-3	R2	BRG/DIST WRT REFERENCE
L3	GND SPD, DRIFT	R3	ETA AT REFERENCE
L4	TIME OF DAY	R4	WIND VELOCITY

Data Window Parameter Definitions

7.49 Data window parameter definitions in navigation Master Mode are shown in Table 7-4. Definitions for windows applicable to weapon delivery are shown in Table 8-2.

Table 7-3 Data Windows in NAV Master Mode

MODE		NAV PANEL REFERENCE SWITCH		
		NAS	NAVAID	OFST NAVAID
NAV/APP	L1	"NAV"	"NAVAID"	"OFST NAV"
	L2	BRG/DIST FROM NAVAID	DME HOLD STATUS	BRG/DIST FROM NAVAID
	R1	CSE TYPE, WPT	"FIX"	"FIX"
	R2	BRG/DIST TO REFERENCE	BRG/DIST FROM NAVAID	BRG/DIST FROM OFFSET NAVAID

Table 7-4 Data Window Parameters (Navigation Mode)

PARAMETER	DEFINITION
ALIGN TYPE	Sample format "GYRO CPS". Either GYRO CPS or STRD HDG can be displayed.
ALIGN STATUS	Sample format "ALIGN". Either ATT ONLY, ALIGN, DGRD NAV, NAV RDY, or a flashing NAV indication can be displayed.
ALIGN ACCURACY	Sample Format "0.8". Accuracy number between 0.8 and 8.0 can be displayed with leading zeros or INIT, ATTD, or A+H.
TIME IN ALIGN	Sample Format "03:24". MIN:SEC with leading zeros.
GND SPD, DRIFT	Sample Format "450K 3R". 3 digit display for ground speed to the nearest knot; 2 digit display for drift angle to the nearest degree; Drift angle can be either right "R" or left "L".
TIME OF DAY	Sample Format "1234:59". HHMM:SS with leading zeros.
BRG/DIST WRT REFERENCE	Sample Format "010/125". BEARING 001–360 degrees. DISTANCE 3 digit field to the nearest nm when > 100nm, to the nearest 0.1 nm when < 100nm. In the NAS mode the BRG is TO the reference, in the NAVAID and OFFSET NAVAID modes the BRG is FROM the reference. DIST field set is to "XXX" if greater than 999 nm. Both bearing and distance fields are blanked if data is invalid.
ETA AT REFERENCE	Sample Format "1244:48" HHMM:SS with leading zeros. When the ETA at the destination is 20 seconds hence, the ETA flashes for 5 seconds.
WIND VELOCITY	Sample Format "200/ 35K". Direction 001–360 degrees. Speed – 3 digit field to the nearest knot. Both data fields set to "XXX" if data invalid.
CSE TYPE, WPT	Sample Format "PLN W12". When NAS is selected as the reference either PLN, DRT, or FIX can be displayed for course type based upon the NAS Panel COURSE switch. For NAVAID and OFFSET NAVAID reference types, the course type is FIX independent of the COURSE switch setting, and WPT is blanked. Either W00–19, I00–I19, O00–O19, N20 – N39, or M40–M49 can be displayed for the waypoint number when NAS is selected as the reference.
DME HOLD STATUS	Sample Format "HOLD". With the NAV Panel DME HOLD Switch in the OFF position, no data is displayed. In the HOLD position, a HOLD indication is displayed.

UP FRONT CONTROLLER

7.50 The UFC (Figure 7-5) and HUD scratchpad are the primary means by which the pilot interfaces with the NAS. In the TA-4 the aft UFC is active only when the rear cockpit has control of the NAS.

7.51 There are two types of data entry associated with the scratchpad; toggle data and numeric data entry. Toggle data entry is characterized by cycling a data field between two or more predefined choices (e.g. N and S, E and W, ACCEPT, REJECT, and EXIT etc.). The current toggle data choice is shown in the DEB (refer to paragraph 7.55). Pressing any numeric key toggles the field to the next choice, and subsequent keystrokes continue to cycle the field. Pressing the CLR key once will restore the original value. The selection is enabled when the ENT key or one of the arrow keys is pressed. Under numeric data entry, the desired numeric value is placed within the DEB using the 1-9 and RDR/O keys.

Numeric Entry Error Handling

7.52 Before the DEB moves off a numeric field a validity test is carried out. If the test passes, the value is accepted and the action of the L, R, or ENT key is carried out. If the test fails the DEB flashes. Pressing the CLR key will stop the flashing and re-display the previous value of the parameter. Data entry can then proceed in the normal manner.

UFC Keys

7.53 The keys on the UFC are categorized into three groups: page access keys, data entry keys, and miscellaneous keys.

Page Access Keys

7.54 Page access keys are used to display a particular page in the scratchpad. A brief explanation of the use of each page access key is contained in Table 7-5. A detailed explanation is provided later in the section associated with each particular function (e.g. Communications, Navigation, Air-to-Ground).

Table 7-5 UFC Page Access Keys

KEY	FUNCTION
PRG	Program Key. Pressing the PRG key displays a prompt in the HUD scratchpad for entry of the desired air-to-surface program number (0 thru 9) when in A/G Master Mode. If a program number other than 1 to 4 is entered, pressing the program change button will select program 1.
COM	Communication Key. The COM key is used to tune the ARC 182.
UDT	Update Key. The UDT key is used to initiate an update procedure.
CHG	Change Destination Key. Pressing the CHG key displays a prompt in the HUD scratchpad for entry of a desired destination. Any valid Waypoint (00-49) may be entered. If an "X" point is entered, the DEB flashes, and the page remains displayed.
NAV	Navaid Key. The NAV key is used to tune the TACAN and VOR/ILS. In addition the NAV key is used during a navigational update procedure.
MRK	Mark Key. Pressing the MRK key initiates a mark procedure.
WPT	Waypoint Key. Pressing the WPT key displays a prompt in the HUD scratchpad for entry of a waypoint number. Following entry of a waypoint number, data associated with the entered waypoint is displayed in the HUD scratchpad for review and/or alteration. Data associated with waypoints, initial points, offset points, nav aids, and markpoints are accessed through this method. If an I point number is keyed in, the ENT Key brings up the first scratchpad page for I points which contains the same data as the waypoint display. A second selection of the ENT key calls up the associated O Point page. Pressing the ENT Key again when the Offset point display is reached, will remove the scratchpad from the HUD. Changing an I point to a W point will "hide", but retain any Offset and POP data associated with the I point, so that if in the future that W point is returned to an I point it will have an Offset and POP equal to the former conditions. With Offset points the bearing/distance and latitude/longitude fields are linked, in that if one is altered the other changes to match the latest coordinates. If an Offset point is given a DTOA, the NAS automatically removes the associated I point DTOA if one existed. If a number between 20 and 39 is keyed in, NAVAID point data is displayed, and only the DTOA field can be altered. Upon keying in a number between 40 and 49 the Markpoint display is presented. The DEB can only be moved to the elevation and DTOA fields, all other data on the page is generated by the markpoint procedure.

Table 7-5 UFC Page Access Keys (Continued)

KEY	FUNCTION
MBS	Millibars Key. This key is used to enter the barometric pressure setting between 850 and 1100 millibars.
DTA	Data Key. The DTA key gives access to the Data Menu and nine associated functions, through the selection of the appropriate numeric key. The following DTA options are available: 1. INU. Either automatically at power up, or following the selection of DTA 1, ENT the INU scratchpad is displayed. During the INU alignment procedure the inertial position and elevation are enterable, however the previous and the newly inserted values will alternate back and forth in the display until accepted by the INU. 2. TIME OF DAY. At power on the system clock is set to 0000:00 and automatically begins counting up. Following the insertion of the time, the clock will start when the ENT key is depressed. CIU and DP software part numbers are shown on this display. 3. DTM. The three toggle options available are : LOAD, UNLOAD, and EXIT. Actioning the EXIT option clears the scratchpad without changing the status of the DTM. Once initiated, LOADING and UNLOADING captions flash until replaced by the caption COMPLETE. If a DTM error is detected, BAD CHECKSUM or INCOMPATIBLE is displayed. If a DTM is not inserted, selecting the DTM scratchpad results in a DTM NOT AVAILABLE caption. 4. SHT DWN (INU Shutdown procedure). The toggle options ACCEPT and EXIT are available. Changes to the other data fields should be carried out before actioning the selected option. The INU shutdown procedure calculates INU radial error rate and CEP. 5. RAD ALT. This function is used to set the Radar Altimeter LAWS Warning at any value between zero and 5000 feet. 6. OFST NAVAID. Bearing, Range and Elevation values that determine the OFFSET vector applied to the tuned Navigation Aid are set on this page. The power on default condition is 090/0 NM and zero feet elevation. 7. COPY. Data may be copied from any waypoint (00-49) to a waypoint within the flight planned route structure (00-19). Both the FROM and TO fields must be specified before the ENT Key is selected. 8. AUTO BRIL (Automatic Brilliance). This toggle entry field turns the HUD Automatic Brilliance feature ON or OFF. When selected ON, the intensity of the HUD symbology is adjusted as a function of the light falling on the HUD optics. This function is only available when the right hand DU is selected to DAY. 9. FAULT. This menu line allows the pilot to display the NAS Active Fault list. One or more depressions of the BIT key will scroll down all active faults and extinguish the BIT light, in which case the line immediately below "FAULT LIST" is blank. G The G option is a toggle data field. Toggling the DEB to ZERO G and pressing ENT will reset the maximum and minimum G carets to the current G value.

Data Entry Keys

7.55 The data entry keys are used to position the data entry box (DEB) around a desired data field and to enter the desired data. An explanation of each key is given in Table 7-6. The data entry box is a rectangle that is initially displayed around the first of the most commonly used data field in a scratchpad display. Data entry is accomplished by performing the following steps:

1. Position the DEB over the field to be entered using the left or right arrow keys as required.
2. Enter the new data, using numeric or toggle data entry.

3. Conclude the entry by pressing the ENT key, the left arrow key, or the right arrow key.

NOTE

First press of the CLR key during data entry clears the most recent keystroke. A second press returns the field being entered to its original state.

Miscellaneous Keys

7.56 Three keys remain which do not fit into any of the previous categories. A brief explanation of each is given in Table 7-7.

Table 7-6 UFC Data Entry Keys

KEY	FUNCTION
L	Left Arrow Key. The L Key tests data validity within the DEB, and if successful moves the DEB one field to the left. If the validity check fails, control remains on the current data entry item and the DEB flashes.
R	Right Arrow Key. The R key has the same function as the L key except the DEB is moved to the next numeric data field to the right. Those fields skipped by the R key can be reached by backstepping with the L key.
CLR	Clear Key. With numeric data entry the first press of the CLR key removes the last keystroke from the DEB. A second selection clears all keystrokes and re-displays the original value. When toggle data entry is in progress, pressing the CLR key re-displays the original value. If a scratchpad is not displayed, selecting this key removes the flashing breakaway cross, and stops the commanded airspeed from flashing.
0-9 and RDR/0	Numeric Keys. The numeric keys are used to insert numeric data, toggle a data field, or select a menu item from the scratchpad data menu (DTA key). If the DEB is displayed around numeric data, the numeric keys insert numerals. If the DEB is displayed around non-numeric data, any numeric key can be used to toggle the non-numeric data to the next state (i.e., N and S, E and W, L and R, etc.). The RDR/0 key is a dual function key. This key, in addition to having a numeric function, is used to qualify either a Radar Update or Radar Mark procedure.
ENT	Enter Key. Pressing the ENT key initiates a check on the data contained within the DEB. If the test fails, control remains on the current scratchpad display and the DEB flashes. If the test passes, or there is no DEB associated with that page, the scratchpad is removed.

Table 7-7 UFC Miscellaneous Keys

KEY	FUNCTION
BIT	Built-In-Test Key. The BIT key is a round key located in the upper left corner of the UFC. This key contains a lamp which lights upon system detection of an equipment failure. Concurrently with the lighting of the lamp, a "FAIL" message is displayed in the scratchpad area of the HUD and at the bottom of the displayed alphanumeric DU. Pressing this key acknowledges the failure, removes the message from the scratchpad and DU, and turns off the lamp.
DCL	Declutter Key. Three mode dependent levels of declutter are provided. Each time the DCL Key is pressed the declutter level is changed in a cyclic manner. This key has no effect on the scratchpad display.
STP	Step Destination Key. Pressing the STP Key commands the NAS to "step" to the next defined waypoint in the flight plan (Waypoints 00 to 19). From Waypoint 19, the STP function wraps around to Waypoint 00. There is no scratchpad associated with the STP Key.

COCKPIT TELEVISION SENSOR

7.57 The CTVS provides a video picture of HUD symbology, for recording on the AVTR. In the TA-4 the CTVS video can be displayed on the rear cockpit display units.

HUD POWER SUPPLY

7.58 The HUD power supply is a low voltage power supply providing the HUD with the necessary operating voltages for displaying HUD symbology, UFC operation, CTVS operation, and displaying the standby reticle.

HUD SWITCH

7.59 The HUD switch, located on the main instrument panel to the right of the HUD, controls power to the HUD and CTVS as shown in Table 7-8.

Table 7-8 HUD Switch Functions

POSITION	FUNCTION
HUD	Switches the HUD LVPS on. The LVPS supplies power to the HUD and CTVS.
OFF	Switches the HUD LVPS off.
STBY	Switches aircraft power (28VDC) to the standby sight and switches power from the 15VDC power supply to the CTVS.

DISPLAY UNIT

7.60 Two display units are located on the main instrument panel of each cockpit. The DU has a raster video cathode ray tube and a peripheral keyboard of 20 keys for selection and entry of items displayed on the CRT. The DU is shown in Figure 7-7.

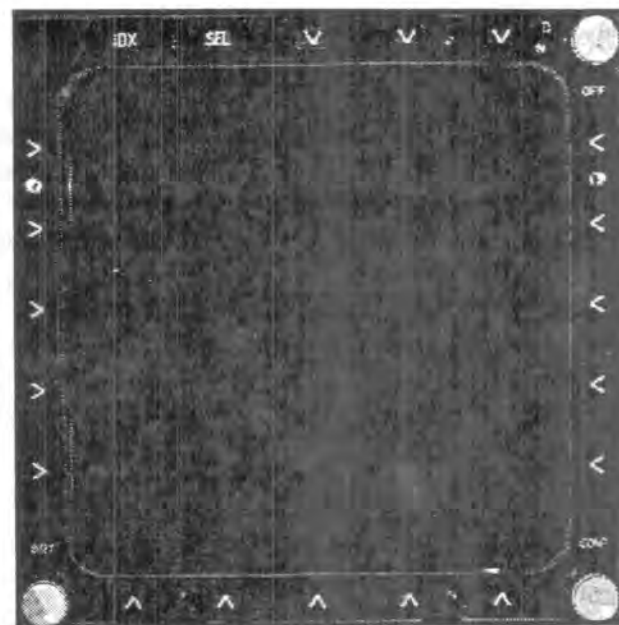


Figure 7-7 Display Unit

Peripheral Keys

7.61 The 20 pushbutton keys located around the periphery of the DU are divided into two hardkeys (index (IDX) and select (SEL)) and eighteen softkeys. Softkeys are used to select those functions displayed on the DU adjacent to the keys. These keys are described in the discussion of the individual display pages throughout the remainder of this chapter.

Index Key

7.62 Pressing the IDX key with text video selected will display the MAIN INDEX page. The MAIN INDEX page provides access to all other display pages (see Figure 7-8).

Select Key

7.63 The SEL key selects the type of video to be displayed on both DUs. In the A-4, and front cockpit of the TA-4, pressing the select key on either DU toggles radar and text video between the right and left DUs. At power on the default combination is text video on the left DU and radar video on the right DU.

7.64 In the rear cockpit of the TA-4, pressing the select key on either DU cycles between four possible combinations as follows:

Left DU	Right DU
Text Video	HUD Video
HUD Video	Radar Video
Text Video	Radar Video
Radar Video	Text Video

7.65 At power on the default combination is text video on the left DU and HUD video on the right DU.

DU Display Types

7.66 The DU is capable of displaying AGM-65 video, CTVS video, radar video, or display-processor-generated text (16 lines by 23 characters). When the AGM-65 missile is uncaged, AGM-65 video is displayed on the right DU. If the NAS senses a fault with the right DU, AGM video will be displayed on the left DU. This video remains displayed until the missile is launched or deselected. CTVS video is displayed in the TA-4 rear cockpit when selected, and in the front cockpit if the aircraft is on the ground and the AVTR VIEW button is pressed. During AVTR VIEW playback, CTVS video is displayed on the right DU for a duration of approximately 15 seconds.

Display Processor Generated Text

7.67 Information is available to the pilot in the form of text displayed on the DUs. Figure 7-8 shows the display pages available.

Multiple Page Indices

7.68 Some indices are displayed on a series of pages instead of just one page. In these cases, arrows appear in the lower corners of each page in the series. Pressing the softkey adjacent to the right arrow advances the display to the next page in the series. Pressing the softkey adjacent to the left arrow reverts the display to the previous page in the series. Each page within a series is numbered in the upper right to identify its position within the series. Both keys offer a continuous scroll facility.

Data Entry

7.69 Specific pages require or allow data entry. Some standard guidelines for data entry apply from page to page. Three types of data entry are performed on the DU text pages: selectable, toggle, and numeric.

a. *Selectable Data Entry.* Pressing the softkey adjacent to the desired item results in the selection of that item and the next appropriate page is displayed.

b. *Toggle Data Entry.* Toggle data entry displays a parameter name in standard video and the current state in inverse video. Pressing the softkey adjacent to the parameter name changes the inverse video display to the next possible state. Repeated presses of this softkey cycles the display through all of the possible states for that parameter. The state in which it is left is the selected state.

c. *Numeric Data Entry.* Numeric data entry pages have ENT (Enter), CLR (Clear), RET (Return), and the numbers 0 through 9 displayed around their perimeter. In the centre is the name of the parameter being entered and a DEB in inverse video. Pressing the softkey adjacent to a numeral 0 through 9 enters that number in the data entry box. Once all the digits have been entered in the DEB, selecting the ENT legend initiates a reasonableness check of the entered value. If the value is reasonable, the next appropriate page is displayed. If the data is rejected, the page remains and the DEB flashes. Initial pressing of the clear key removes the last keystroke. A subsequent press clears the data entry box to its original state. Selection of the RET legend returns the display to the previously displayed page without entering a new value into the system.

Failure Indication

7.70 If the NAS detects a failure, the FAIL legend appears in the lower centre of the DU text display at the same time as the HUD fail message appears and the UFC BIT lamp illuminates. When this occurs the fault list should be reviewed on the HUD scratchpad and acknowledged. Once all failures have been acknowledged, the FAIL legend is removed.

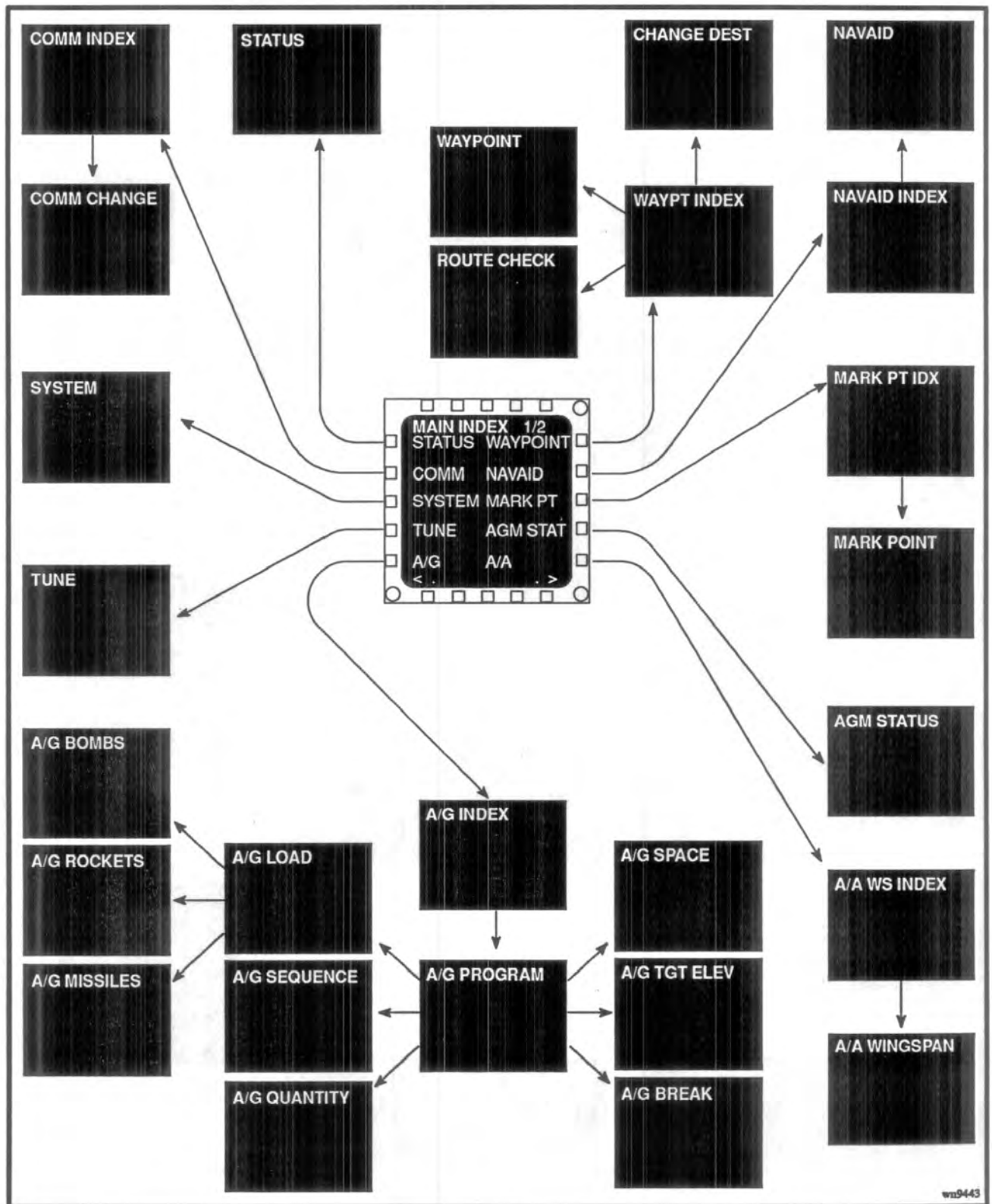


Figure 7-8 DU Display Pages (Sheet 1 of 2)

AL 9(5)

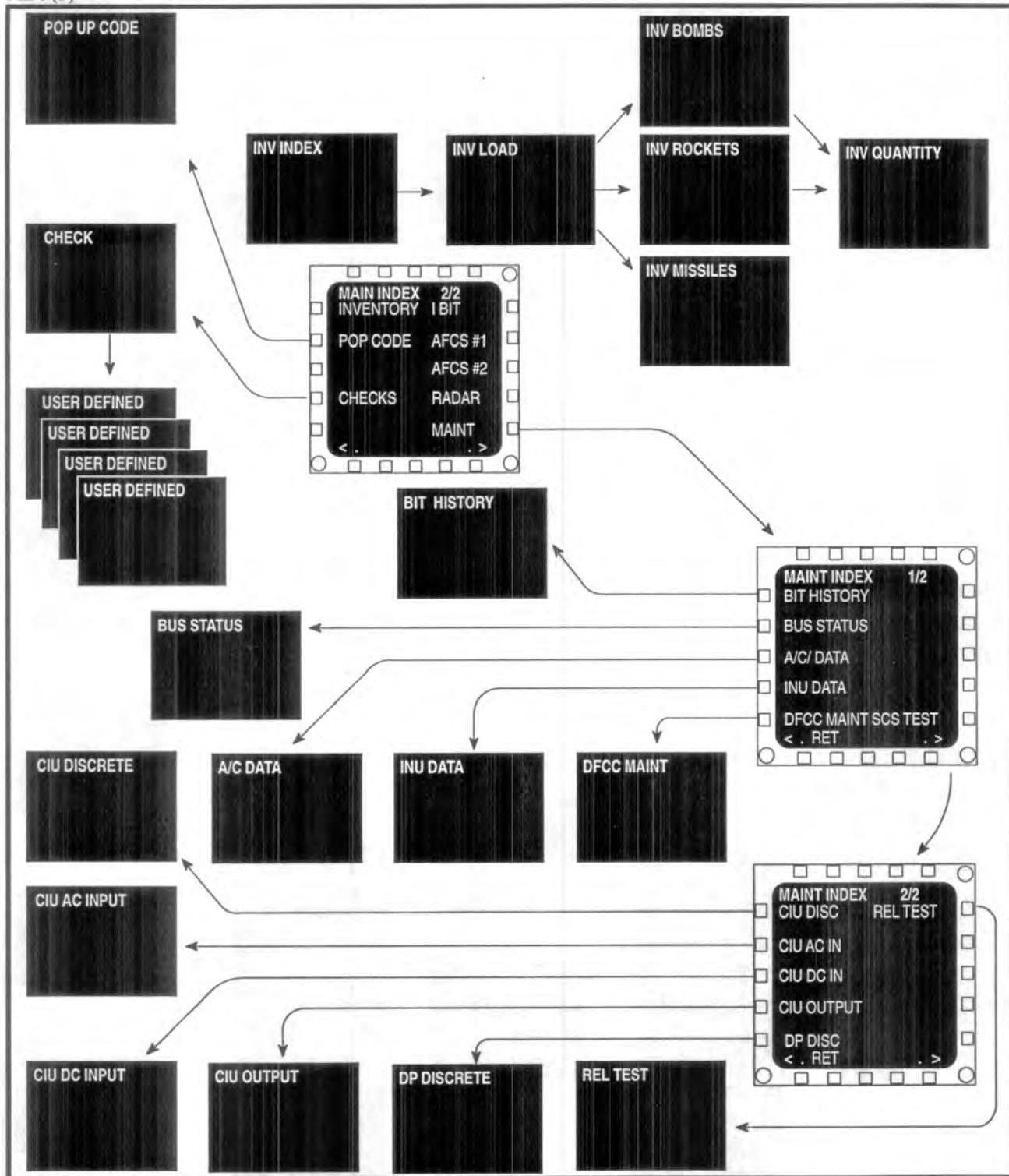


Figure 7-8 DU Display Pages (Sheet 2 of 2)

Brightness and Contrast Controls

7.71 A brightness (BRT) and contrast (CONT) control are provided on the lower left and the right of the DU.

Day/Night/Off Switch

7.72 The day/night/off (D/N/OFF) switch applies power to the DU and selects the day or night brightness mode for that DU. In addition, the right DU switch (forward cockpit only for the TA-4) disables the DU and HUD autobrilliance function when N is selected, and controls lighting to the UFC.

AL 5(0)

Radar Symbol Brightness Control

7.73 Radar video is generated from both the CIU and the radar system. Brightness of these two symbol sets is separately controlled. Symbols generated by the radar (e.g. channel numbers, iron cross, stepped pyramid, range marks) are controlled by the radar symbol brightness control located on the right side of the HUD. Symbols generated by the CIU (e.g. targets, cursor lines, mode titles) are controlled by the upper two soft keys on the right side of the DU. The softkeys are not active in radar Air Modes.

Pressing the upper of these two keys steps the symbol brightness up to the next brightness level. Pressing the lower steps the symbol brightness down one level. There are eight symbol brightness levels in all.

NOTE

The selection of various levels of CIU generated symbols also influences the range marker intensity dependent on the MK INT selected on the RCP.

DATA TRANSFER SYSTEM

GENERAL

7.74 The Data Transfer System is used in conjunction with the Mission Data Ground Terminal (MDGT) to programme pre-planned parameters into the NAS. Aircraft performance data can also be obtained and downloaded if the NAS is calculating the required parameter. The Data Transfer System comprises the Data Transfer Module (DTM) and the Data Transfer Module Receptacle located on the right console.

LOADING

7.75 The DTM is loaded to the NAS via the UFC Data submenu (DTA 3). The DTM scratchpad display shows the Header as inserted on the MDGT and LOAD/UNLOAD/EXIT options in a DEB which are toggle data entry items with LOAD as the default. The DTM is loaded by toggling to LOAD (if required) and pressing ENT. When loading is initiated, the DEB will automatically toggle to EXIT and the word LOADING will flash on the first line of the scratchpad. When loading is complete, LOADING will be replaced by COMPLETE. The DTM scratchpad can be cleared from the HUD at any time during the loading operation without disrupting DTM loading. If DTA 3 is selected without a DTM in the DTM receptacle a DTM NOT AVAILABLE caption will be shown. If a DTM error is detected by the CIU, a BAD CHECKSUM or INCOMPATIBLE message will be displayed.

NOTE

If the NAS is turned off after loading DTM, then Weapons programmes and Inventory data is lost. To restore these items, the NAS will require reloading, either via DTM or manually via the DU.

7.76 The following parameters can be loaded from the DTM:

LAWS setting.	Inventory.
Cross track codes.	Navaid points.
Marker Beacon sensitivity.	Weapons programs.
Waypoint sequencing.	A/A wingspans.
Waypoints.	Checklists.
TACAN, VOR/ILS and	ARC 182 pre-studied
ARC 182 mode and	frequencies.
initial channel/frequency.	
Selected performance parameters to be captured by the NAS for download to the MDGT.	

UNLOADING

7.77 The DTM is unloaded from the NAS via the UFC Data submenu by toggling the DEB options to UNLOAD and pressing ENT. During unloading the caption UNLOADING will flash on the first line of the scratchpad display and will be replaced by COMPLETE when unloading has finished. The scratchpad display can be cleared at any time once unloading has been initiated without disrupting the unloading operation.

AIRBORNE VIDEO TAPE RECORDER

DESCRIPTION

7.78 The Ferranti Airborne Video Tape Recorder (AVTR), incorporates a Sealed Video Module (SVM) mounted in a Video Interface Module (VIM). The AVTR manually (run mode) or automatically (auto mode) records HUD video via the cockpit television sensor, radar video, or AGM-65 missile video. The AVTR also records, at fixed levels, all audio signals available to the pilot's headset.

OPERATING MODES

7.79 The AVTR has two operating modes, run mode and auto mode.

Run Mode

7.80 When the RUN mode is selected, recording is dependent on the selection of the HUD/RDR pushbutton, and AGM 65 selection and status. Figure 7-9 describes the record modes.

Auto Mode

7.81 In the AUTO mode recording is dependent on the selected Master Mode, AGM 65 selection and status, and update or mark procedures. Figure 7-9 describes the record modes.

CONTROLS AND INDICATIONS

Mode Switch

7.82 The mode switch located on the VIM is a three-position toggle switch used to power the AVTR and select the STBY or RECORD method of operation.

NOTE

The mode switch must be selected to OFF prior to NAS power off, otherwise the tape will remain threaded, and cannot be removed from the SVM.

NOTE

A flashing RUN lamp indicates an abnormality with the SVM tape. The tape could be either at the end of its length, jammed, or the 'playback only' function enabled (red indicator slide on the rear of the tape).

VIEW Pushbutton

7.83 The VIEW pushbutton activates the VIEW test

function of the AVTR. To test the AVTR perform the following:

- a. Record at least 15 seconds of HUD video, verifying that the HUD light on the NAS panel AVTR pushbutton control illuminates.
- b. Press and release the VIEW button on the AVTR. The unit rewinds and plays back the last 15 seconds of recorded HUD video on the right DU.

NOTE

The AVTR playback video can only be displayed while on the ground. If the VIEW button is pressed in-flight, the AVTR will still transition into the VIEW mode, however, no playback video will be displayed.

NAS Controls and Indicators

7.84 The NAS panel contains two push buttons labelled HUD/RDR and AUTO/RUN. These are used to control AVTR operation as follows:

- a. *HUD/RDR*. The HUD/RDR switch selects HUD video via the CVTS, or radar video, for recording on the AVTR. Each press of the switch toggles between HUD and RDR with the current selection backlit. The backlighting indicates when HUD or radar video is being recorded regardless of whether it is selected by the pilot or automatically selected by NAS.
- b. *AUTO/RUN*. The AUTO/RUN switch selects the recording mode. Each depression of the switch toggles between AUTO and RUN with the current selection backlit. This switch is active only when the VIM mode switch is in the STBY position.

NOTE

The two AVTR switches on the TA-4 rear cockpit NAS panel only provide indication of the current NAS video selections. The switches themselves have no function.

AL 5(0)

Table 7-9 AVTR Mode Operation.

SELECTION	FUNCTION
OFF	Power is removed.
STBY	When the mode switch is moved from OFF to STBY with an SVM installed, the tape is threaded and ready for use. If left in the STBY position, the NAS panel pushbuttons will determine when recording takes place and what is recorded.
RECORD	When the mode switch is placed in the RECORD position, the AVTR begins recording and remains in the record mode until the mode switch is moved to STBY or OFF, or the SVM reaches the end of the tape. The source of the video recorded is determined by the NAS.

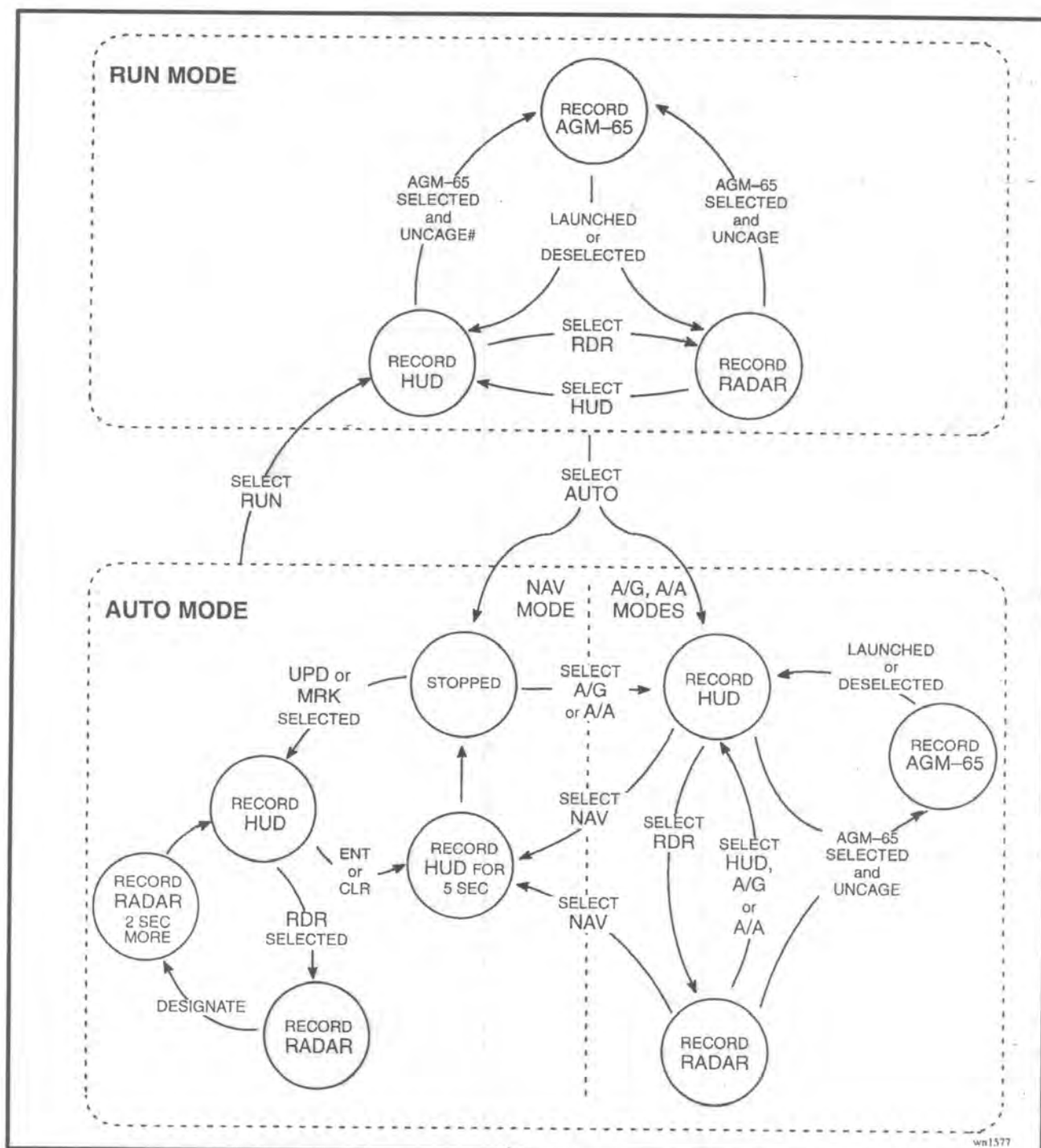


Figure 7-9 AVTR Record Modes

BUILT IN TEST

INTRODUCTION

7.85 NAS Built In Test (BIT) consists of Continuous BIT (C-BIT) and Initiated BIT (I-BIT). In addition, there is also a Power On BIT which is executed automatically during system initialization. Following initialization, C-BIT is run as a background task with no operator input required. I-BIT is commanded manually by the operator and is permitted only while the aircraft is on the ground.

ANNUNCIATION OF FAULTS

7.86 Failures detected during I-BIT, C-BIT or Power On BIT, on equipment that interface with or are a part of the NAS are recorded in the CIU-stored BIT history record. Of these failures, those considered significant cause a FAIL indication on the HUD and DU, and the UFC BIT key to illuminate. The DU BIT HISTORY pages provide a pass/fail indication for each test performed during BIT. Each digit of the BIT HISTORY corresponds to a test performed by the CIU or to subsystem fault data received by the CIU. When a failure is detected, the digit associated with that failure changes from 0 to 1. This digit remains a 1 even if the test later reports a passing condition. The BIT HISTORY data can be reset to all zeros by pressing the soft key adjacent the ERASE legend on BIT HISTORY page 2. The BIT HISTORY should be cleared at the start of each flight to erase failures from previous flights. When the DTM is unloaded, BIT HISTORY is downloaded to the DTM. C-BIT is automatically downloaded to the DTM.

PILOT'S FAULT LIST

7.87 Illumination of the BIT key on the UFC and the FAIL message in the HUD and DU, alert the pilot that a new fault annunciation has been added to the pilot's fault list. The nature of the fault (if not already obvious) can be ascertained by calling up the Fault List on the HUD scratchpad. This is accomplished by selecting FAULT on the DTA sub menu (DTA 9). The pilot's fault list (Figure 7-10) displays unacknowledged fault annunciations in line left 2 (L2) and up to six acknowledged annunciations in the remaining lines. When a fault annunciation is first displayed, it is an unacknowledged fault annunciation. A fault is acknowledged by pressing the BIT key on the UFC. Once a fault annunciation is acknowledged, it is pushed down to the next line (L3) in the list. Previously acknowledged faults are also pushed down

one line. The annunciation on line L4 is pushed to line R1. If there are more than six faults, the first fault will be pushed off the scratchpad to a second acknowledged faults page when the seventh fault is acknowledged. If no more unacknowledged fault annunciations exist, line L2 becomes blank, the BIT key goes out, and the FAIL legend on the DU is removed. If more unacknowledged fault annunciations exist, each must be acknowledged as it appears in line L2.

NOTE

When the CIU or HUD has failed such that scratchpad operations are no longer possible, the DU FAIL message may be the only failure indication. The BIT HISTORY pages are the only means of determining the new fault, and the failure cannot be acknowledged.

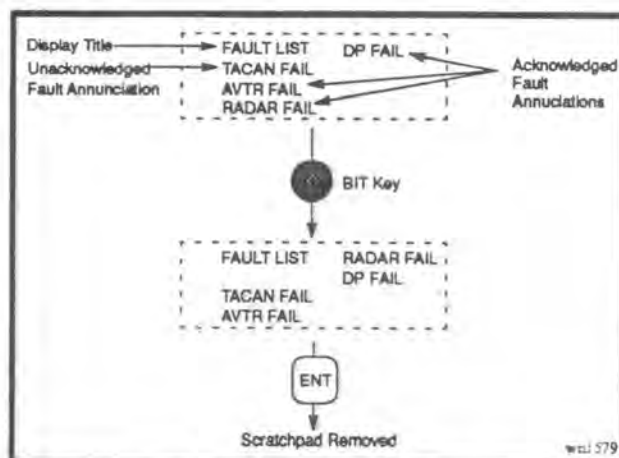


Figure 7-10 Sample Pilot Fault List Scratchpad Display

HUD FAILURE ANNUNCIATION: ATTITUDE

7.88 Whenever a difference in pitch or roll of more than 10 degrees is detected between the INU attitude data displayed on the HUD, and ADI attitude, the word ATTITUDE is displayed on the HUD. Once alerted by this message, it is up to the pilot to decide which information is incorrect. The message is also displayed when INU attitude is declared invalid. The message remains displayed as long as the condition exists, and cannot be cleared from the HUD.

NAS INITIATED BIT

7.89 NAS I-BIT is a commanded BIT mode that can only be performed with Weight-On-Wheels. The test is executed in two halves, designated Initial and Final. During I-BIT the CTU checks all NAS equipment and presents displays to the operator as a confidence measure. If the NAS detects a failure during I-BIT that failure will be annunciated on the pilot's fault list with a corresponding FAIL message. The fault(s) can be acknowledged at any stage during I-BIT.

7.90 I-BIT is initiated by pressing the softkey next to the I-BIT legend on the DU MAIN INDEX page 2. In addition to the I-BIT legend, the state of I-BIT is also displayed. The conditions indicated are:

- OFF – I-BIT is not selected
- INITIAL (In inverse video) – Initial half of I-BIT executing
- INITIAL – Initial half complete
- FINAL (In inverse video) – Final half of I-BIT executing
- FINAL – Final half complete

7.91 The normal sequence of events for running I-BIT is as follows:

- Toggle the I-BIT softkey to INITIAL.
- Confirm the correct audio tone while waiting for the inverse video to time out, then check the initial position displays, as shown in Table 7-10.
- Toggle the I-BIT softkey to FINAL.
- Confirm the correct audio tones while waiting for the inverse video to time out, then check the final position displays, as shown in Table 7-10.
- Toggle the I-BIT softkey to OFF.

7.92 During I-BIT the DADC is declared invalid and the FPM, VSI and AOA are removed from the HUD. This information will not be re-displayed until 90 seconds after completion of I-BIT has elapsed.

7.93 The operator can step through the I-BIT sequence as he chooses, but if the softkey is pressed prior to the inverse video timing out, some tests may not be completed.

Table 7-10 I-BIT Test Display

INDICATION		INITIAL POSITION	FINAL POSITION
UFC	BIT Lamp	ON	OFF
HUD	(TEST displayed)		
	Altitude	10000	25000
	Airspeed	276	384
	Mach No.	.50	.90
	Radar Altitude	100	100
	Destination	Current steerpoint	Current steerpoint
	Range	As computed by INU	As computed by INU
ADI	Vertical Pointer	Full scale left	Centred
	Horizontal Pointer	Hidden from view	Centred
	Sphere	Not Affected	Not Affected
	Warning Flag	Not Affected	Not Affected
HSI	Bearing Pointer	as computed by INU	as computed by INU
	Course Deviation Bar	1/2 scale left	1/2 scale right
	Deviation Bar Flag	Out of view	In view
	Distance Display	as computed by INU	Shutter In View
	Course Pointer	45 deg left of hdg	45 deg right of hdg
	To/From Arrow	TO	FROM
	Compass Card	Not Affected	Not Affected
	Off Flag	Not Affected	Not Affected
NAS PANEL	HUD/RDR Lamps	On	Off
	AUTO/RUN Lamps	On	Off
AUDIO TONES	Bomb Release	2 second pulse	Off
	LAW Tone	Off	2 second pulse
	ARC 182		4 second interrupted tone

RADAR INITIATED BIT

7.94 The automatic radar power-on BIT can be duplicated in the air by pressing the softkey adjacent to RADAR on the DU MAIN INDEX page 2. The test will run only until a failure is detected. If no failure is detected then the test will run to completion in the normal 3 minutes. The detected failure is displayed to the operator as a 3 digit code on the DU beneath the RADAR legend. The code can be deciphered by maintenance personnel.

AFCS INITIATED BIT

7.95 There are two AFCS I-BIT tests. These require Weight-On-Wheels and the airspeed to be less than 60 KIAS. The tests are accessed from the DU MAIN INDEX page 2 by pressing the associated softkey.

AFCS Test 1

7.96 AFCS Test 1 allows the AFCS to be engaged on the ground so that disengagement can be checked. When the DU softkey is pressed, the AFCS #1 will be presented in inverse video to cue the pilot that the AFCS can be engaged.

With the AFCS engaged the pilot can then disengage the system (re-engaging between each) by the control column autopilot disconnect switch, emergency aileron trim switch, and half control column stick throw left and right, in any order. Ten seconds from press, the softkey is allowed to complete the test at the end of which the inverse video will time out and the AFCS engage switch, if engaged, will drop out. If the test has not been completed, the softkey can again be pressed and the test continued. Similarly, if the test is completed in less than the time allowed, pressing the AFCS #1 softkey will return the video to normal. Alternatively the AFCS #2 test can be initiated by pressing the appropriate softkey which will swap the inverse video from AFCS #1 to AFCS #2.

AFCS Test 2

7.97 AFCS #2 checks all control and feedback paths. Once the AFCS #2 legend is in inverse video, the operator need only to engage the AFCS and keep his hands and feet off the controls. If any failures are detected during the test, these failures will be placed on the pilot's fault list with the appropriate failure message. When the test is complete the inverse video will extinguish and the AFCS engage switch will drop out.

INERTIAL NAVIGATION UNIT

INTRODUCTION

7.98 The Litton 93 ring laser gyro Inertial Navigation Unit (INU) provides navigation position information to an expected accuracy of 0.8 nm/hr. HUD attitude, heading, vertical speed, normal acceleration and HSI heading are INU derived.

INU CONTROLS

7.99 Control of the INU is via the 5 position rotary INU switch on the NAS panel (as detailed in Table 7-11).

NOTE

The NAS units powered by this switch are the CIU, DP, INU, DADC, 15VDC Power Supply, and 5VDC Power Supply (TA-4).

The INU switch in the rear cockpit of the TA-4 has no function; INU alignment cannot be initiated from the rear cockpit.

Table 7-11 INU Controls

OFF	Removes power from the NAS.
ALIGN	Applies power to the NAS and commences the INU alignment sequence.
NAV	Places the INU into the navigation mode.
GND	Applies power to all NAS components except the INU and is primarily for maintenance use.
TEST	Applies power to the INU and initiates a 15 to 18 minute test sequence. Intended for maintenance use only.

INU ALIGNMENT

7.100 Whenever the aircraft is stationary with power available, and the INU switch is moved from the OFF to the ALIGN position, the NAS is powered up and alignment starts. An INU alignment scratchpad display appears on the HUD as soon as power is applied to the NAS. Additionally, the right data windows on the HUD provide alignment data during the alignment sequence.

Alignment Types

7.101 Two types of alignment are available; stored heading (STRD HDG) alignment, which produces full navigational accuracy after 90 seconds; and gyrocompass (GYRO CPS) alignment, which provides full navigational accuracy after 7 minutes 36 seconds. If the INU has previously been aligned and the aircraft not moved, then the INU will attempt a STRD HDG alignment on the next power up.

NOTE

Selection of the INU mode to TEST will invalidate the stored heading conditions.

7.102 If the INU determines that the conditions for a STRD HDG alignment cannot be met, it automatically commences a GYRO CPS alignment. At any stage during a GYRO CPS alignment, the NAS may be selected to NAV for aircraft taxi. When the aircraft is stationary again, reselecting ALIGN will continue the alignment. An enhanced accuracy alignment can be performed by carrying out a GYRO CPS alignment, selecting NAV, turning the aircraft through greater than 70 degrees within 10 minutes and reselecting ALIGN for a minimum of 4 minutes. The aircraft does not have to be positioned at the initial alignment point. The enhanced alignment will give an expected accuracy of 0.5 nm/hr, but this will not be displayed on the INU scratchpad.

Alignment Scratchpad Display

7.103 The INU scratchpad display (Figure 7-11) is automatically displayed at power on, or can be selected via the DTA 1 keys. Aircraft position can be changed if required, using toggle and numeric data entry. If latitude or longitude is changed by greater than 1 arc minute, the alignment sequence will recommence. Table 7-12 describes each item in the scratchpad display.

Alignment Data Windows

7.104 From power up until the selection of NAV, an abbreviated form of the scratchpad alignment page is displayed in the right data windows. The data windows (Figure 7-11) contain the following entries from top to bottom: INU mode, INU status, accuracy, and time in align.

NOTE

If NAV is not selected prior to taxi, or should the aircraft move more than 4 inches in 8 seconds during the alignment sequence, the INU will automatically enter NAV mode to the accuracy of the system when movement commenced. The NAV caption in the status field of the data windows and the INU scratchpad display will flash as an alert to this condition. Once the movement has ceased the alignment sequence may be recommenced by moving the INU switch to NAV and then back to ALIGN; or, if alignment is complete, the INU switch can be placed to NAV while the aircraft is moving.

AL 5(0)

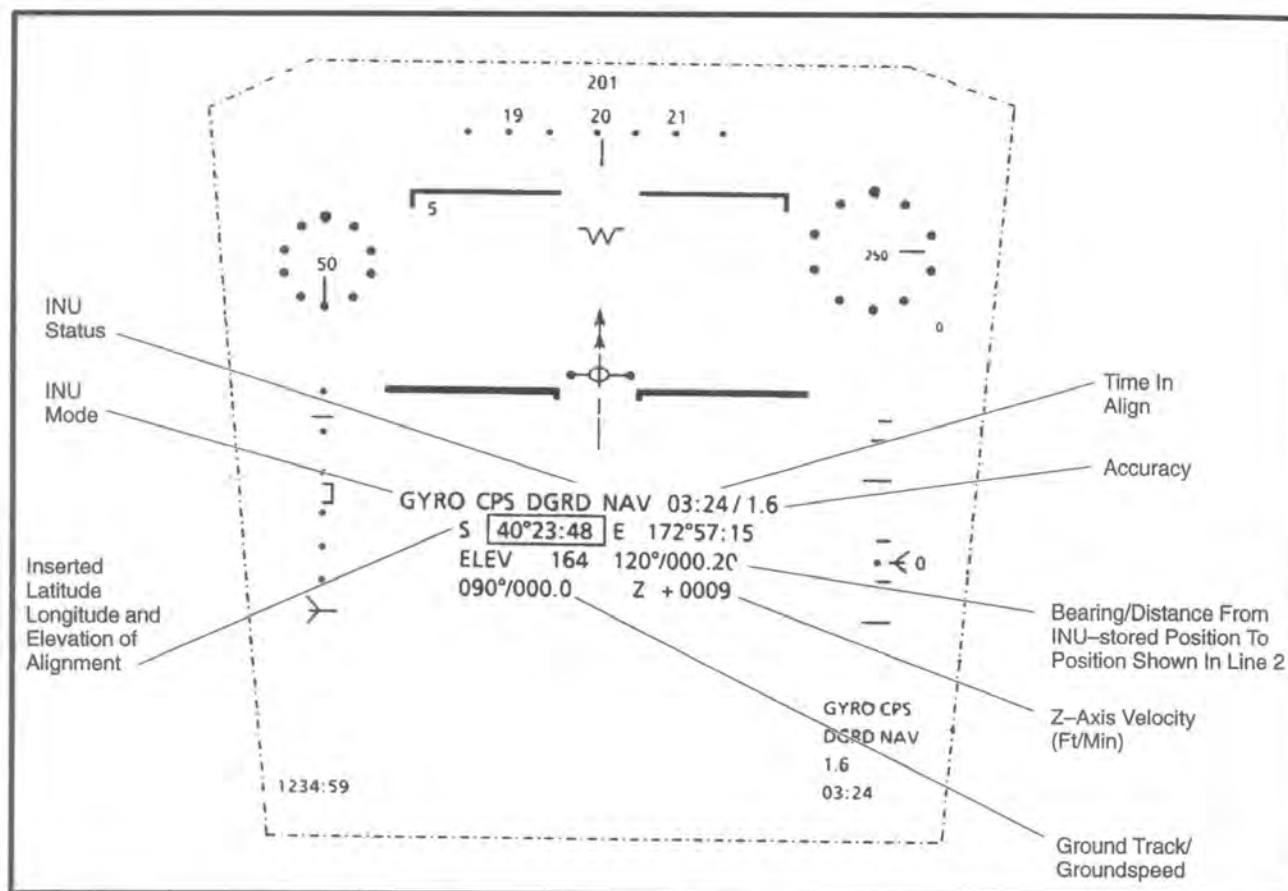


Figure 7-11 INU Scratchpad Indications During INU Alignment

Table 7-12 INU Scratchpad Indications During INU Alignment

ITEM	DESCRIPTION
MODE	This entry displays the current INU mode. The INU transitions through the following modes during the power-on, alignment, and navigation processes. OFF INU is not yet communicating with the CIU. STANDBY INU is communicating with the CIU. ORIENT INU has been commanded by the CIU to begin alignment. STRD HDG INU has started a stored heading alignment. GYRO CPS INU has started a full gyrocompass alignment. NAV INU is performing attitude and navigation functions. The NAV legend is displayed whenever the INU switch is moved to NAV. It is also displayed and flashes when aircraft movement during INU alignment forces the INU into the NAV mode. FAIL INU boresight constants stored in the INU do not match INU boresight constants stored in the CIU.
STATUS	This entry advises the pilot of the status of the INU during the alignment sequence. The following status messages are available. OFF Displayed 0 thru 9 seconds into alignment and indicates no attitude or navigation available. ATT ONLY Displayed 9 thru 90 seconds into alignment and indicates only attitude information is available. DGRD NAV Displayed 90 thru 478 seconds into a full gyrocompass alignment and indicates that the displayed degraded navigation accuracy is to be expected if the INU switch was moved to NAV. NAV RDY Displayed 478 seconds into a GYRO CPS alignment and 90 seconds into a STRD HDG heading alignment indicating full navigation accuracy has been reached.
TIME IN ALIGN	This entry is the elapsed time that the INU has been in align.
ACCURACY	This entry shows the current accuracy of the INU in nautical miles per hour. The values for this entry are INIT (initial condition), ATT (attitude available), A+H (attitude and heading available), 8.0, 7.2, 6.4, 5.6, 4.8, 4.0, 3.2, 2.4, 1.6, and 0.8.

AL 5(0)

Table 7-12 INU Scratchpad Indications During INU Alignment (Continued)

ITEM	DESCRIPTION
LATITUDE, LONGITUDE AND ELEVATION	These are the values of latitude, longitude and elevation that were last entered. The INU commences the alignment automatically using these values. If they are incorrect and the pilot elects to change them such that the difference between the old and the new position is greater than 1 arc minute, INU alignment is restarted as a gyrocompass alignment.
BEARING/DISTANCE	This is the bearing and distance from the INU-stored position to the position shown in line 2 of the scratchpad display.
GROUND TRACK/ GROUND SPEED	The current ground track, groundspeed, and z-axis velocity are displayed during alignment to allow the pilot to assess the current system drift values for evaluating the effects of switching to NAV before alignment is complete.

NORMAL OPERATION

7.105 After the INU switch is moved to the NAV position, the INU scratchpad display becomes an information-only display. The position and elevation fields are continuously updated to reflect the current aircraft position including any adjustments as a result of position updates. In-flight alignment of the INU is not possible. To prevent the loss of the INU function in flight due to an inadvertent selection of the OFF position on the INU switch, the switch must be pulled out to get into the OFF position. Additionally, when the aircraft speed is greater than 50 knots or weight is off the wheels, movement of the INU switch from NAV to ALIGN has no affect until the aircraft speed falls below 50 knots and weight is on the wheels.

7.106 Should the aircraft main generator fail, a battery within the INU allows the inertial position and attitude tracking to be maintained for a minimum of 10 seconds. If power is restored within 10 seconds, operation continues normally. If power is not restored within 10 seconds, the INU commences an orderly shutdown of its functions. It is essential therefore, that the ram air turbine (RAT) is deployed as soon as practical after a main generator failure.

NOTE

Prolonged operation of the horizontal stabilizer at low airspeeds while utilizing RAT power could affect the ability of the INU battery to support continued operation of the INU.

POSITION UPDATING

7.107 The INU determined aircraft position can be updated while in the NAV Master Mode, by performing one of four update procedures; Overfly, HUD visual sighting, Radar or Navaid. For Overfly, HUD and Radar updates the Nav Panel Reference switch must be selected to NAS. For a Navaid update the Reference switch may be in any position. Position updates are accomplished by identifying to the NAS the location of the destination. With each method, the NAS obtains the location of the destination relative to the aircraft. This location is used to compute the

aircraft present position by comparing it with the INU determined aircraft position. The difference between these two is displayed in the HUD scratchpad in the form of a lat/long error and an altitude error. The error can be rejected or accepted to update the INU. In deciding to accept or reject the update, consideration should be given to the accuracy of the INU (typically 0.8nm/hr or better), the accuracy of the type of update, and the accuracy of the method of determining the aircraft position relative to the destination.

NOTE

During the update procedure, the INU itself is not updated. The CIU calculates how far the INU position is from the updated position and, if the update is accepted, stores the error as a buffer. The buffer is then applied to all INU outputs before the information is displayed to the pilot. Therefore INU accuracy is unaffected by poor updates, although INU positional data displayed to the pilot will be affected.

7.108 Update procedures are initiated by pressing the UDT key on the UFC. This displays the position update scratchpad and inhibits auto-sequencing to the next destination until the update procedure is terminated. The scratchpad will initially display an "H" (for HUD) in anticipation of a HUD update procedure. This will change to an "R" (RDR) or "N" (NAVAID) if either a radar or navaid update procedure is initiated. An "O" (Overfly) will be displayed if the overfly update option is selected. Following designation the position error is displayed as a bearing/range and if available, an altitude error which is qualified "HI" or "LO" to indicate the direction of the error. Initiating an update procedure while in the A/G or A/A Master Mode, results in the message INVALID NAS MODE being displayed in the update scratchpad. If an error message is displayed the update should be aborted by pressing the UFC ENT key, and the appropriate switch selection corrected. The update can then be re-attempted. The scratchpad can be removed from the HUD at any point during an update by pressing the ENT key.

AL 5(0)

Overfly Update

7.109 The overfly update enables a low level update to be carried out when directly overhead the waypoint. After the update procedure is initiated by pressing the UDT key, the aircraft is flown to the waypoint and the overfly (OFLY) position of the radar/fix switch on the control stick selected when directly over the waypoint. At this instant, the position and altitude errors are added to the position update scratchpad. The altitude error is based on the difference between radar altimeter derived aircraft altitude (based on radar altimeter height above ground and waypoint elevation from the navigation data base) and the baro-inertial aircraft altitude. Radar altimeter height is used if available regardless of whether the RAD ALT switch is in RAD ALT or WPNS. The pilot can accept or reject either of these values for updating the INU determined position by toggling the corresponding ACCEPT/REJECT legends to the desired states. The update is completed by pressing the ENT key on the UFC.

HUD Updating

7.110 The HUD update enables position updating by visually sighting the destination (waypoint) through the HUD without having to fly over the point. Once the update procedure has been initiated by pressing the UDT key, the destination symbol can then be slewed over the waypoint and designated (DESIG) by the radar/fix switch on the control stick.

NOTE

To obtain an altitude error, the radar must be in the air-to-ground ranging (AGR) mode. The radar mode must be manually changed.

7.111 Position and altitude (provided the radar is in AGR) errors are then shown on the HUD scratchpad. Further slewing/trimming of the destination symbol (for refinement) can then be carried out. The position error values are continuously computed and displayed until the update procedure is complete. The pilot can accept or reject either of the errors in the same manner as the overfly update.

NOTE

If the destination is designated without the radar in AGR an altitude error can be obtained by selecting AGR and redesignating.

Radar Updating

7.112 The radar update enables position updating by designating the radar defined destination (waypoint).

Radar updating may only be performed when the radar is in the Ground Map, Beacon, or Sea modes, and the waypoint is identifiable on radar. A radar update is initiated by pressing the UDT key followed by the RDR key. The radar cursors can then be slewed over the destination and designate (DESIG) pressed when they overlay the waypoint. The position error only is displayed. Further slewing of the radar cursor (for refinement) can be carried out, and the error accepted or rejected as required. If a radar update procedure is initiated with the radar in an unsuitable mode, the message INVALID RADAR MODE is displayed in the update scratchpad display. If the radar is then switched to an acceptable mode, the message is removed.

Navaid Updating

7.113 The navaid update enables position updating using either TACAN, VORTAC, or VOR/DME radial and distance information. Navaid updating may be performed when the tuned navaid is one of the 20 nav aids in the navigation data base (N20 thru N39). The update is initiated by pressing the UDT key followed by the NAV key if in NAS reference; or the UDT key only if in NAVAID or OFST NAVAID reference. The NAS searches the nav aid points stored in the navigation data base for the nav aid with the same channel as that currently tuned. The NAS computes the difference between the nav aid-derived aircraft position (obtained from the nav aid range and bearing and the nav aid position as stored in the navigation data base) and the INU determined aircraft position to obtain a position error. The difference is added to the position update scratchpad display which can then be accepted or rejected. Since nav aid accuracy decreases with range, nav aid updates should be performed as close to the station as possible. If valid range and bearing information is not being received an INVALID NAVAID DATA message will be displayed in the update scratchpad display. If nav aid data reception returns, the message is removed.

RADIAL ERROR RATE CALCULATION

7.114 In order to assess the performance of the INU, it is necessary to carry out the shutdown procedure. The procedure must be carried out with the aircraft stationary, prior to moving the INU switch out of the NAV position. The Shutdown is carried out by selecting the SHUTDOWN scratchpad page from the DTA menu and entering the actual position of the aircraft if necessary. When the EXIT/ACCEPT DEB option is accepted, the INU will calculate the radial error rate (RER) for that flight. This data is used by the INU to compute its cumulative radial error rate (RER), and circular error probability. This information may be downloaded to the DTM for maintenance recording.

AL 5(0)

7.115 The shutdown scratchpad displays:

- a. Latitude longitude and elevation of the point at which the INU was last aligned;
- b. The bearing and distance from the INU-stored position to the position displayed on line 2 of the scratchpad; and
- c. The computed RER of the previous flight, the time in the navigation mode, and the cumulative RER CEP for the previous 8 flights. When the shutdown procedure is complete, the DEB legend will automatically toggle to EXIT, and the RER and cumulative RER CEP are updated.

NOTE

The shutdown procedure is recommended prior to any NAS power-off, as it allows the INU to complete an orderly shutdown.

SYSTEM ALTITUDE

7-115a The INU vertical channel, which outputs both INU altitude and VSI information, is inherently unstable. To overcome potentially large errors, inertial altitude is combined with pressure altitude data from the DADC (corrected for temperature) to give baro-inertial altitude. Baro-inertial altitude is used by the INU for all vertical

calculations, and is subject to INU drift. (See Figure 7-11a.)

7-115b The altitude used for weapons delivery to calculate height above target is called system altitude. System altitude is baro-inertial altitude corrected by the CIU with any navigation update buffer. Therefore prior to any navigation update, system altitude is identical to baro-inertial altitude. System altitude is only as accurate as the last update, and is subject to drift from the last update time.

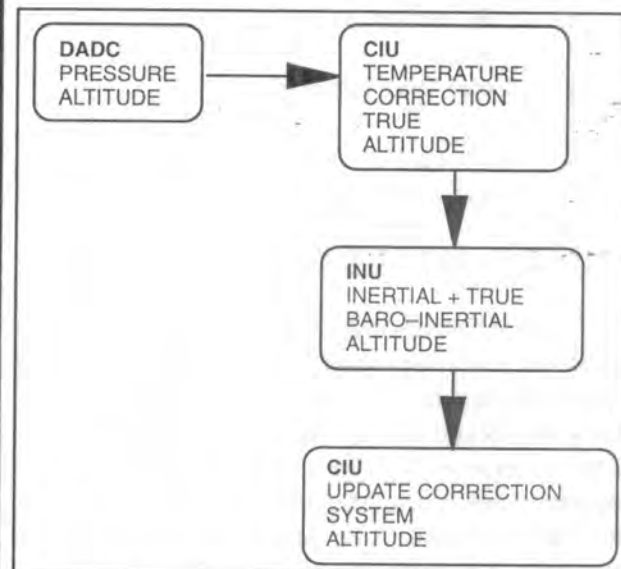


Figure 7-11a System Altitude Derivation

COMMUNICATIONS

INTRODUCTION

7.116 The communications fit of the A/TA-4 comprises of the following equipment:

- a. VHF/UHF transmitter/receiver
- b. AN/ARC 182(V)
- c. UHF transmitter/receiver
- d. ARC 159(V)
- e. VHF receiver (VOR/ILS)
- f. VIR 130
- g. Secure Voice Equipment
- h. KY 58
- i. Audio Panel
- j. Groundcrew Intercom Box

AN/ARC-182 UHF/VHF

7.117 The AN/ARC-182(V) VHF/UHF AM/FM radio consists of a receiver-transmitter located in the forward engine compartment, and an antenna located directly behind the cockpit canopy. The radio provides two-way AM/FM communication in 25 kHz increments over a frequency range of 30 to 399.975 MHz within four bands as illustrated in Figure 7-12. Monitoring of four guard frequencies is permitted dependent on the band that the main receiver is operating in. Tuning and control of the radio is via the UFC and DU. On/off/volume control is located on the audio panel. Transmission is accomplished by forward pressure on the throttle comm switch. When tuning a VHF channel, the ARC-182 will automatically change to AM or FM, whichever is required. When tuning a UHF frequency, the AM/FM selection must be made by the pilot via the systems page on the DU. (The default setting is AM).

7.118 In the TA-4, the ARC-182 can only be powered on or off from the front cockpit. The OFF position of the

ARC-182 on/off/volume control in the rear cockpit has no function. Tuning of the ARC-182 is available in both cockpits, but only to the cockpit that controls the NAS as determined by the NAS control transfer switches. Either pilot can transmit on the ARC-182 regardless of which cockpit has control, however, they can not transmit simultaneously. The transmit keying circuits are interlocked such that when one pilot is transmitting, the other is locked out.

7.119 The ARC 182 is not available when operating on the emergency generator, nor with a DC-2 or dual convertor failure. UFC tuning is not available when the CIU has failed. In the event of a DP failure, mode control is not available. The radio defaults to T/R + G, squelch ON, and UHF AM.

Frequency Selection

7.120 Frequency selection is through the UFC COM key or the DU TUNE page. Pressing the COM key on the UFC displays a prompt on the HUD scratchpad. The first line of the scratchpad contains the label COMM and a blank DEB, the second line displays the preset stud and associated frequency to which the ARC-182 is tuned. If the ARC-182 is off, the second line is blanked. Entering one or two digits between 0 and 30 specifies to the NAS that the radio is to be tuned to a preset stud. Entry of four, five, or six digits (with leading zeros less than 100.000 MHz) is required to specify a manual frequency within the ARC-182's range, and sets that frequency as stud 0. Stud 0 always contains the last manually-selected frequency.

7.121 To tune the ARC-182 by the DU, select the TUNE page from the MAIN INDEX 1/2. Ensure COMM is selected as shown above the inverse video, then enter the stud or frequency, as per UFC tuning.

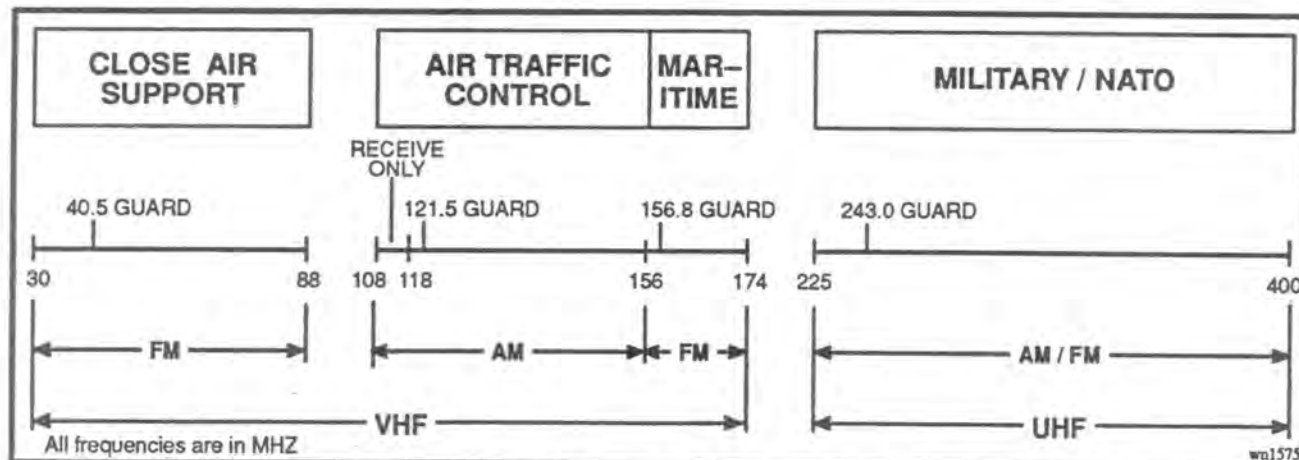


Figure 7-12 ARC-182 Frequency Bands

AL 5(0)

7.122 The frequencies associated with each stud are initially loaded from the DTM but can be altered through the COMM pages on the DU by pressing the softkey to the stud to be changed. This results in the display of the COMM CHANGE page where entry of the new frequency can then be made. The presently tuned stud (shown in inverse video) cannot be assigned a new frequency.

Mode Control

7.123 The ARC-182 operating parameters are controlled from the SYSTEM page on the DU. The SYSTEM page is displayed by selecting SYSTEM from the MAIN INDEX 1/2 page. The SYSTEM page indicates the on/off condition of the ARC-182 and the current state of each of the three ARC-182 operating parameters. These three parameters and their selectable states are listed in Table 7-13 along with a description of each.

**Table 7-13 AN/ARC-182
Operating Parameters**

PARAMETER	SELECTION	FUNCTION
Mode	T/R	The transmitter and main receiver are enabled
	T/R+G	The transmitter, the main receiver, and guard receiver are enabled
	AM	UHF channels are amplitude modulated
	FM	UHF channels are frequency modulated
SQUELCH	ON	Main receiver squelch is enabled
	OFF	Main receiver squelch is disabled

ARC-159 UHF

7.124 The ARC-159 UHF Radio consists of a control panel (Figure 7-13) with a built-in receiver-transmitter located on the right console, and an antenna located on the lower forward fuselage. Transmission is accomplished by rearward pressure on the throttle comm switch. In the event of a throttle mic-switch failure, an alternate transmit facility is provided by holding the audio panel ALT switch in the ALT TX position. The ALT TX position is spring-loaded and returns to the ALT position upon release.

7.125 In the TA-4, a control panel is located in both the front and rear cockpits. The rear cockpit control panel is a

remote control unit and has no receiver-transmitter. Control of the radio is determined by the ARC-159 control transfer switches. Either pilot may switch control from the front to the rear or vice versa by pressing the ARC-159 control transfer switch. Both switches are operable at all times. Either pilot can transmit on the ARC-159 regardless of which cockpit has control, however, they can not transmit simultaneously. The transmit keying circuits are interlocked such that when one pilot is transmitting, the other is locked out.

NOTE

When the ARC-182 and ARC-159 are tuned to or near the same frequency, simultaneously transmitting (i.e. front cockpit on ARC-182 and rear cockpit on ARC-159, or vice versa) can result in garbled reception for the receiving station(s). Additionally, sidetone may be distorted.

7.126 28 VDC power for the ARC-159 is provided by the Primary DC Bus. The radio is available when operating on the emergency generator, but not with a dual convertor failure.

Controls and Indicators

7.127 The operating controls and indicators are shown in Figure 7-13 and described in Table 7-14.

NOTE

It is possible to position the preset channel selector between the stud indents, resulting in a spurious frequency being tuned despite a valid stud number being displayed. This 'false indent' problem may be fixed by turning the channel selector knob a small amount either way to ensure positive indent.

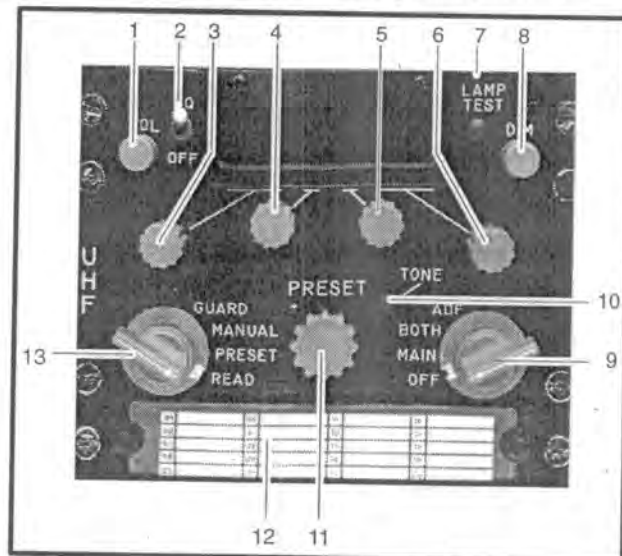


Figure 7-13 ARC-159 Control Panel

Table 7-14 ARC-159 Controls and Indicators

ITEM No.	CONTROL	DESCRIPTION	FUNCTION
1.	VOL	Potentiometer	Adjusts audio output level.
2.	SQ/OFF	Toggle switch	Enables or disables main receiver squelch. Squelch is disabled in OFF position.
3.	Frequency	Wafer switch and readout	Selects and indicates frequency increments of 100 MHz and 10 MHz during manual operation.
4.	Frequency	Wafer switch and readout	Selects and indicates 1 MHz increment during manual operation.
5.	Frequency	Wafer switch and readout	Selects and indicates 0.1 MHz increment during manual operation.
6.	Frequency	Wafer switch and readout	Selects and indicates frequency increments of 25 MHz and 50 MHz during manual operation.
7.	LAMP TEST	Pushbutton switch	Test readout lamps.
8.	DIM	Potentiometer	Adjust light intensity of readout.
9.	Function selector	Wafer switch	
	OFF		Turns off power to radio set.
	MAIN		Selects normal receive and transmit operation. Transmitter is keyed by microphone push-to-talk switch or TONE button.
	BOTH		Enables guard receiver in addition to functions described for MAIN.
	ADF		Enables automatic direction-finding equipment. Main and guard receivers are enabled.
10.	TONE	Momentary contact push-button switch	Keys transmitter and modulates transmitted signal with 1020 Hz tone.
11.	PRESET	Memory drum switch assembly	Preset channel selector. Sets channel when mode selector is in PRESET or READ.
12.	Chart	Operating frequency chart	Provides semipermanent record of preset frequencies.
13.	Mode selector	Wafer switch	
	GUARD		Tunes radio set to guard frequency. Displays guard frequency on readout.
	MANUAL		Permits manual selection of frequency. Selected frequency is displayed on readout.
	PRESET		Permits selection of any of 20 preset channels. Displays selected channel number on readout in 3rd and/or 4th digit position. Remaining 4 digits are blank
	READ		Displays frequency of selected preset channel on readout.

VIR-130 COMM MODE

7.128 The VIR 130 VOR/ILS system is capable of receive-only communication on one of 200 VHF frequencies from 118.00 to 127.95 MHz with 50 kHz channel spacing. VOR/ILS com frequency tuning can be accomplished from the UFC NAV key or the DU TUNE page. Tuning is as for the ARC-182 with the exception that because the VIR-130 is being tuned, NAV is selected as opposed to COM. Entry of a comms frequency for the VOR/ILS system is only allowed during PAIRED tuning (i.e. not when DME HOLD is in use).

7.129 In the TA-4, control of the VIR-130 via the UFC or the DU is determined by the NAS control transfer switches.

7.130 The VIR-130 is powered from the Forward Monitored DC bus and is not available when operating on the emergency generator, or during a DC-2 or dual converter failure.

INTERCOM SYSTEM

7.131 The intercom system allows intercommunications

between cockpits and groundcrew, and allows pilot voice to be recorded on the AVTR. The intercom can be activated either by upward pressure on the throttle comm switch or by placing the audio panel mic switch to HOT. The hot microphone function is overridden whenever either of the radios is keyed for transmit. The MUTE pushbutton silences both the ARC-182 and ARC-159 receive audio to both cockpit headsets allowing uninterrupted intercom communication. An alternate amplifier, controlled through the audio panel provides backup in case of a failure in the primary audio receiver amplifier or the COMM switch on the throttle. A ground crew intercom station located in the left wheel well provides groundcrew connection to the intercom system.

AUDIO PANEL

7.132 The AUDIO panel (Figure 7-14) located on the right console controls the volume of audio signals, allows selection of the alternate radio amplifier, and provides an alternative transmission facility for the ARC-159. The functions of the audio panel controls are shown in Table 7-15.

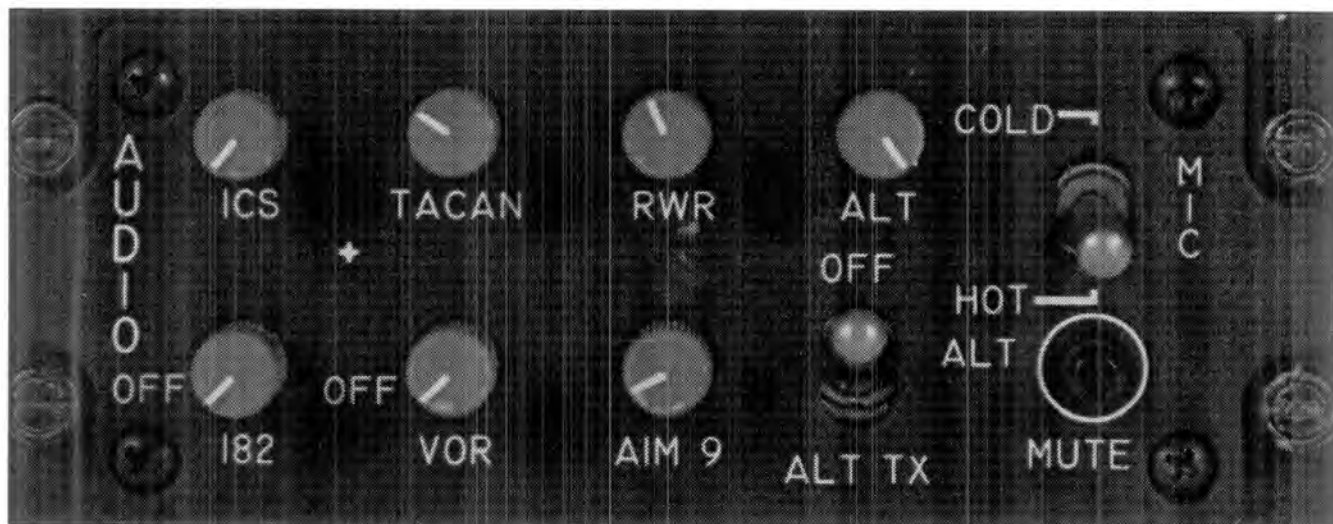


Figure 7-14 Audio Panel

AL 8(0)

Table 7-15 Audio Panel Controls

CONTROL	TYPE OF CONTROL	FUNCTION	
ICS	Rotary control	Volume control for the intercom system	
182	Rotary control	On/off (TA-4 front cockpit only) and volume control for the ARC-182	
TACAN	Rotary control	Volume control for the TACAN	
VOR	Rotary control	On/off (TA-4 front cockpit only) and volume control for the VIR 130	
RWR	Rotary control	Volume control for the radar warning receiver	
AIM 9	Rotary control	Volume control for the AIM-9L	
ALT	Rotary control	Volume control when the OFF/ALT/ALT TX switch is in the ALT or ALT TX position	
OFF/ALT/ALT TX	3 position switch	OFF	Primary audio amplifier and volume controls are used.
		ALT	Alternate audio amplifier and ALT volume control used.
		ALT TX	ARC-159 is keyed for transmission. Alternate audio amplifier and ALT volume control used.
MIC	2 position switch	HOT	Provides continuous intercom which is overridden whenever either radio is keyed for transmission.
		COLD	COMM switch must be pressed to communicate on intercom.
MUTE	Pushbutton	Silences ARC-182 and ARC-159 received audio. AVTR recording is not affected. In the TA-4 either pilot may activate the mute which will affect both headsets (and the groundcrew intercom).	

7.133 All volume controls adjust the volume to the headset and do not affect the level at which audio is recorded on the AVTR.

NOTE

Low altitude warning, weapon release tone and marker beacon tone volumes are not adjustable.

SECURE VOICE EQUIPMENT

General Description

7.134 The secure voice system is used for ciphering (coding) or deciphering (decoding) audio routed through the ARC-182. The system consists of the KY-58 Remote Control Unit (RCU) located on the rear left console, (Figure 7-14a), and a programmer (Figure 7-14b) located in the rear engine compartment. During ciphered

transmissions, audio from the pilots microphone is routed through the audio panel to the KY-58 control panel assembly where it is enciphered. The enciphered audio is then routed back to the audio panel and then to the ARC-182 receiver-transmitter for transmission. During reception of ciphered information, the ciphered audio is routed from the ARC-182 receiver-transmitter to the audio panel and then to the KY-58 control panel assembly for deciphering. The deciphered audio is routed back to the audio panel and to the pilot's headset. Secure voice is not available when operating on the emergency generator, nor with a DC-2 or dual converter failure.

TA-4 AIRCRAFT ONLY

7.134a There is no RCU fitted in the aft cockpit of the TA-4.

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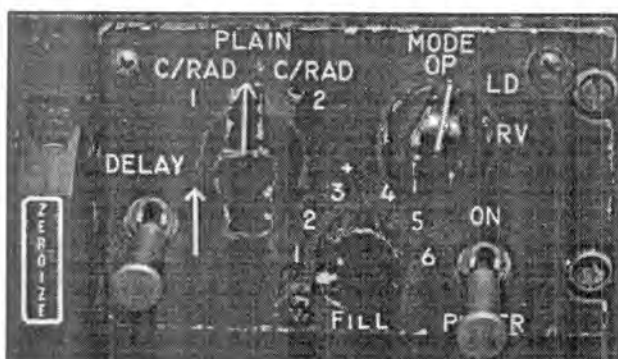
Table 7-15a KY-58 RCU Controls and Indicators

CONTROL	DESCRIPTION	FUNCTION
POWER switch	2 position switch	Power control switch for unit.
MODE	Rotary control	
OP		Set for operational use.
LD		Load function. Maintenance use only.
RV		Rekeying Variable function. Not used on A-4.
C/RAD Switch	Rotary control	
PLAIN		When selected, allows plain, unciphered speech.
C/RAD 1		Enables cipher operation of the ARC-182.
C/RAD 2		Not used on A-4
ZEROISE Switch	Guarded 2 position switch	When operated, deletes all variables set.
DELAY Switch	2 position switch	Selected to increase the probability of achieving initial synchronisation when the signal has to be retransmitted between stations.
FILL Switch	Rotary control	Controls selection of different variables.

7.134b The KY-58 Programmer is a Controlled Cryptographic Item (CCI). Standard procedures for the handling of Communications Security (COMSEC) Equipment are to be adhered to during the operation of the KY-58 System. The variables used in the KY-58 are valid for a seven day period. They are changed at 0000Z on the 7th, 14th, 21st, and 28th of each month. For operations during these periods, a changeover may be required.

Controls and Indicators

7.134c The operating controls and indicators for the KY-58 RCU are shown in Figure 7-14a and Table 7-15a. The operating controls and indicators for the KY-58 Programmer are shown in Figure 7-14b and Table 7-15b.

**Figure 7-14a KY-58 Remote Control Unit**

7.134d Refer to 7-15c for the aural tones generated by the KY-58.

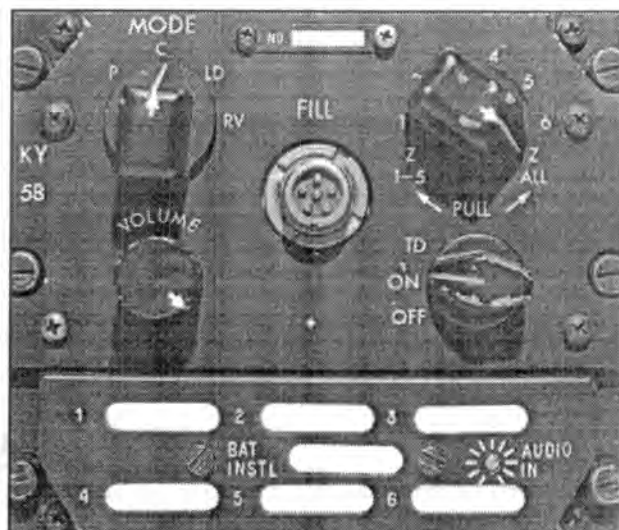
**Figure 7-14b KY-58 Programmer**

Table 7-15b KY-58 Programmer Controls and Indicators

CONTROL	DESCRIPTION	FUNCTION
POWER switch	Rotary control	Power control switch for unit.
FILL switch	Rotary control	
Z 1-5		Zeroise variables 1-5.
1-6		Controls select of variables 1-6.
Z ALL		Zeroise all variables.
MODE	Rotary control	
P		Plain. Unciphered transmissions.
C		Cipher. Set for operational use.
LD		Load function. Maintenance use only.
RV		Rekeying variable function. Not used on A-4.
VOLUME	Potentiometer	Programmer volume control.

Table 7-15c KY-58 Aural Tones

Tone	Occurs	Indicates	Procedure
Continuous beeping (crypto-alarm) with background noise.	At turn-on.	Power-on.	Clear by keying AN/ARC-182 radio.
Continuous beeping (crypto-alarm).	At any time other than turn-on.	Equipment failure.	Repeat turn-on procedure. If the alarm does not clear the system is unserviceable.
Continuous tone (priority-alarm).	Any time an empty storage register is addressed and the AN/ARC-182 is keyed and held.	1. An empty storage register. 2. An invalid cryptovariable is present. 3. Equipment fails to receive a valid cryptovariable sent by a remote keying operation. 4. Equipment failure.	System requires new loading of cryptovariables.
A single beep.	1. Each time radio is keyed with equipment in cipher and a filled storage register is addressed. 2. When a cryptovariable has been successfully received. 3. At beginning of a receive cipher message.	1. Begin speaking. 2. A valid cryptovariable is present. 3. The cryptovariable has passed the parity check.	
A single beep in time delay.	After preamble is sent.		Begin speaking.
Background noise.	1. At turn-on. 2. While generating a cryptovariable.	That the KY-58 is working properly.	If no background noise is heard at select-on or when the equipment is used to generate a cryptovariable, the equipment is unserviceable.
A single beep followed by a burst of noise.	At any time in cipher text mode.	Receiver on different variable than transmitter.	Check KY-58 has correct variable set.

NOTE

If no background noise is heard at select-on or when the equipment is used to generate a cryptovariable, the equipment is unserviceable. This is important, because the absence of noise indicates a malfunction which cannot be otherwise detected since it does not affect the communications capability. It does, however affect the security provided by the KY-58.

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NAVAIDS

INTRODUCTION

7.135 The navaid fit of the A/TA-4 comprises the following equipment:

- | | |
|------------|---------------|
| a. TACAN | AN/ARN-118(V) |
| b. VOR/ILS | VIR-130 |
| c. ADF | AN/ARA-50 |

7.136 When the Tacan control panel is set to channel 00, frequency selection of the TACAN and VOR/ILS systems are paired, based upon ICAO frequency pairing. Re-tuning one aid will automatically tune the other to the matched frequency. Exceptions to this are DME Hold and VIR-130 Comm mode. Panel tuning is active when the TACAN Panel is set to other than zero, and results in the TACAN and VOR/ILS having to be independently tuned. The ADF operates as a mode of the ARC-159.

Paired Tuning

7.137 In the PAIRED mode, a channel number, frequency, or a limited range of "receive only" VHF frequencies may be entered. When the channel/frequency entered is within the paired range of the VOR/ILS (17X-59Y and 70X-126Y) then the aids are tuned to a matched pair. If the channel is outside the range, then the VOR/ILS is tuned to the VHF Guard frequency 121.5 MHz. When a VOR/ILS frequency is entered the TACAN is tuned to the matching channel number. If the frequency entered is not a navaid frequency, but a VHF communication frequency, then the TACAN remains on the last set channel number.

AN/ARN-118(V) TACAN

7.138 The TACAN Navigation set is a polar coordinate navigation system that determines the relative bearing and slant-range distance to a selected TACAN ground station or range to a suitably equipped aircraft. The ARN-118 operates on 252 channels divided into 126 X and 126 Y channels in the L-band with a frequency range from 962 to 1213 MHz. The maximum operating line of sight range of the ARN-118 is 390 nm when the selected TACAN station is a surface beacon and 200 nm when the selected TACAN station is an airborne beacon.

7.139 The TACAN navigational set consists of a radio receiver-transmitter, a receiver-transmitter adapter, and an electrical equipment mounting base (all located in the forward engine compartment), two antennas (mounted one below the nose section) and the other aft of the tail

section, a TACAN panel (Figure 7-15) located on the right console, and a TACAN antenna select switch located on the right console next to the DTMR. The TACAN antenna select switch provides selection of either antenna (FWD or AFT) or enables the TACAN equipment to select the antenna with the best reception (AUTO). The TACAN panel provides main power on/off control and backup TACAN control. There is no TACAN Panel in the TA-4 rear cockpit. Volume control to the pilot headset is controlled by the TACAN volume control on the audio panel. The volume control on the TACAN panel is not used. TACAN mode and channel selections can be made from either the TACAN panel or the NAS via the DU or HUD. The NAS is the primary controller of the TACAN navigational set.

TA-4 AIRCRAFT ONLY

7.140 Control of the TACAN via the UFC or the DU is only available to the cockpit that controls the NAS as determined by the NAS control transfer switches.

7.141 Power is provided from the forward monitored AC bus and is available when operating on the emergency generator. In the event of a DC-2 convertor or CIU failure, the TACAN will require tuning through the TACAN panel. TACAN information will be displayed on the HSI only. The TACAN will be inoperative following a dual convertor failure. A DP failure will result in the mode defaulting to T/R, if 00 is set on the TACAN panel. The mode can be changed through TACAN panel tuning procedures. After an INU failure, TACAN bearing will still be displayed against the HSI compass card which will be driven to a heading of 360 degrees and fixed.

Operating Modes

7.142 The TACAN system operates in the modes shown in Table 7-16.



Figure 7-15 TACAN Panel

Table 7-16 TACAN Mode Operation

MODE	FUNCTION
OFF	Power is removed from the TACAN system
REC	Receive mode. The TACAN system receives and measures surface beacon fundamental bearing and calculates the relative bearing.
T/R	Transmit-receive mode. The TACAN system provides relative bearing and slant-range distance to the selected TACAN station. The TACAN system must be in this mode to perform a NAVAID position update.
A/A REC	Air-to-air receive mode. Operates as described for the REC mode except the bearing information is received from a suitably equipped, cooperating, reference aircraft.
A/A T/R	Air-to-air transmit-receive mode. The bearing and distance information is received from a reference aircraft.
NOTE On RNZAF aircraft air-to-air bearing is not provided.	
Self Test	Pushbutton on TACAN panel for self confidence test. Operates only when panel tuning is in operation. To carry out the test, momentarily press and check for: 1. TACAN control panel TEST indicator flasher, indicating the TEST indicator is operational. 2. Bearing pointer will slew to 270 degrees for a nominal seven seconds, then slew to 180 degrees and DME will indicate 000.0 ± 0.5 nm. 3. After approximately 15 seconds, DME will drop out and OFF flag will appear and bearing pointer will return to search (CW rotation).

TACAN Panel Control

7.143 When any channel other than channel 00 is selected on the TACAN panel, the TACAN panel provides the selection of the mode and channel. Rotating the channel select controls selects the channel number and rotating the mode switch selects the mode. PANEL tuning will be indicated by the first line of the UFC NAV key scratchpad prompt showing PANEL. The TACAN channel in the second line will reflect the selection on the TACAN panel. Panel tuning results in the TACAN and VOR/ILS having to be tuned independently.

NAS Control

7.144 When channel 00 is selected on the TACAN panel, the NAS has control of TACAN channel selection and mode. The DU SYSTEM page is used to select the TACAN mode. The DU TUNE page or the UFC NAV key and associated scratchpad display is used to select the channel. The DU SYSTEM page indicates the on/off status of the TACAN and the currently selected mode. Pressing the key adjacent to the TACAN mode toggles to the next TACAN mode.

7.145 To tune the TACAN via the UFC NAV key, press the key to display the NAV scratchpad. The first line shows

either "PAIRED" for when the TACAN and VIR-130 are paired, "DME HOLD" for use with non co-located ILS frequencies or "PANEL" for panel tuning. Either a channel number of one, two, or three digits, or a frequency of four or five digits may be keyed into the DEB. The DEB can be positioned over the X indication and toggled between X and Y. The second line displays the channel to which the TACAN is currently tuned, and the frequency to which the VOR/ILS is currently tuned. These fields are individually blanked when the TACAN or the VOR/ILS are OFF.

7.146 To tune the TACAN via the DU TUNE page, press the NAV softkey if required to display the NAV prompt, enter the channel or frequency, and toggle the correct X/Y prior to accepting the tuning.

VIR-130 VOR/ILS

7.147 The VOR/ILS equipment provides bearing and glideslope information, marker beacon indication, and received audio on the VOR/ILS frequencies. The VOR/ILS equipment consists of a VOR/ILS receiver (located in the aft avionics bay), a VOR/localizer/glideslope antenna (located on the vertical stabilizer), and a marker beacon antenna (located on the lower surface of the right wing).

Control

7.148 The VOR/ILS on-off/volume control is located on the audio panel. This control powers the VOR/ILS system and controls the volume of station ident tones. In the TA-4, the rear cockpit on/off function is inoperative. VOR/ILS frequency selection is controlled by the NAS via the DU or UFC. Under paired tuning, entering a channel number or frequency will tune both the VOR/ILS and the TACAN to that station. Control of the VOR/ILS is available only to the cockpit that has control of the NAS as determined by the NAS control transfer switch.

NOTE

Tuning the VOR/ILS to a Comm frequency does not alter the current TACAN channel. However changing the TACAN channel does alter the frequency of the VOR/ILS, even if the VOR/ILS was tuned to a com frequency.

VOR Reception

7.149 The system can receive any one of 160 VOR frequencies from 108.00 to 117.95 MHz with 50 kHz channel spacing excluding odd tenths of MHz from 108.00 to 111.95 MHz. When tuned to a VOR station the system provides the information shown in Table 7-17.

Table 7-17 VOR Information and Display

INFORMATION	DISPLAY
Bearing to the VOR Station	HUD Bearing Pointer HUD Data Window HSI Bearing Pointer
VOR deviation, which represents the position of the aircraft relative to the HSI selected fixed course.	HUD CDI HSI CDI
To-From flag indication relative to the VOR station.	HSI
Audio of the VOR identification.	Audio Panel
Track angle error to capture course	HUD TAE caret ADI Vertical Bar

ILS Reception

7.150 The system can receive any one of 40 localizer frequencies from 108.10 to 111.95 MHz with 50 kHz

channel spacing odd tenths of MHz only. The system automatically tunes a separate glideslope receiver to a matching glideslope frequency from 329.15 to 335.00 MHz with 150 kHz channel spacing. When tuned to an ILS station the system provides the information shown in Table 7-18.

Table 7-18 ILS Information and Display

INFORMATION	DISPLAY
Localizer Deviation. The magnitude and direction (left or right) of the aircraft deviation relative to the centre of the localizer antenna pattern (runway centreline).	HUD ADI (Vertical bar)
Glideslope Deviation. The magnitude and direction (up or down) of the aircraft deviation relative to the centre of the glideslope antenna pattern (optimum glide path to the runway).	HUD ADI (Horizontal bar)
Audio of the localizer ident.	Audio Panel

Marker Beacon Reception

7.151 The marker beacon receiver is always tuned to a frequency of 75.00 MHz. Audio is heard upon passing over a marker beacon station. Marker beacon tones are not volume adjustable. The marker beacon receiver may be set for HI or LO sensitivity via the DU SYSTEM page. Pressing the key adjacent to the VOR/ILS line toggles the sensitivity between HI and LO.

DME Hold

7.152 (Refer Figure 7-4). The DME HOLD function is designed for ILS approaches where the DME channel is not matched to the ILS frequency. DME HOLD operation is available only when the DME HOLD switch on the NAV panel is selected to hold, and TACAN control is via the NAS. With DME HOLD selected, only ILS channel/frequencies can be tuned. If a non ILS entry is made, the DEB will flash. The required DME channel/frequency must be tuned prior to selecting DME HOLD. If the DME HOLD switch is subsequently selected to OFF, the DME will remain on the presently tuned DME and the VOR/ILS will be automatically re-tuned to the associated paired frequency.

AN/ARA-50 AUTOMATIC DIRECTION FINDER

7.153 The ADF is used in conjunction with the ARC-159 UHF radio and consists of an amplifier and an antenna located in the nose section. ADF is selected from the mode selector on the ARC-159 control panel. Bearing to the tuned UHF station is displayed on the HSI bearing pointer. Whenever ADF is selected on the ARC-159 control panel,

the DF flag is displayed on the HSI. ADF is available when operating on the emergency generator except when the horizontal stabilizer emergency override is operated. A dual converter failure will render the ADF inoperative.

CAUTION

No other navigation indications are altered while ADF is selected hence conflicting data will be presented on the HSI.

APG-66 (NZ) RADAR

INTRODUCTION

7.154 The APG-66 (NZ) Radar is a coherent, I/J band pulse doppler radar using low and medium PRF. It consists of six functional LRU's which are the Antenna, Transmitter, Low Power Radio Frequency Unit, Digital Signal Processor, Radar Computer, and Radar Control Panel (RCP). The antenna is a slotted-plate planar array on a two-axis gimbal mount and has a beamwidth of 6.7 degrees vertically and 6.3 degrees horizontally. An electric drive is used for steering and stabilization giving a scan rate of 65 degrees per second.

7.155 The following modes and sub-modes are available:

- a. Air Search (AIR)
 1. Acquisition
 2. Single Target Track (STT)
 3. Situation Awareness (SAM)
- b. Air Combat (ACM),
 1. HUD Acquisition (HUD ACQ)
 2. Vertical Acquisition (VERT ACQ)
 3. Boresight
 4. Slewable ACM
- c. Ground Map (GM)
 1. Expanded X2
 2. Expanded X4
 3. Doppler Beam Sharpening (DBS)
- d. Air-to-Ground Ranging (AGR)
- e. Beacon (BCN)
- f. SEA 1 and SEA 2
 1. Expanded X2 (SEA 1 only)
 2. Expanded X4
 3. Maritime Target Track (MTT)

RADAR CONTROLS

7.156 The radar is controlled either by the RCP, or through the NAS using HOTAS controls. Gain control is provided for GM, BCN and SEA modes. Radar mode selection is summarized in Table 7-19.

Radar Control Panel

7.157 The RCP (Figure 7-16) located forward of the throttle, contains the controls, described below, that are

necessary for preselection of radar performance parameters or overriding automatic control.



Figure 7-16 Radar Control Panel

Mode Control

7.158 The 8-position mode control switch selects the radar operating mode which is then displayed at the top left of the radar DU. As shown in Table 7-19, the Master Mode switch can override the RCP mode selection. The following RCP selections are available:

- a. OFF – All power is removed from the radar system. A detent is provided so that the knob must be depressed before the switch can be rotated either into or out of the OFF position. When OFF is selected after the system has been operating, power is not removed for approximately 4 seconds, during which time the antenna is caged.
- b. STBY – Selection of STBY results in the radar commencing time-out on a built-in 3-minute time delay before the system will operate in any other mode. A STB message is displayed on the radar DU when in STBY. If any mode other than STBY is selected from OFF, the radar BIT is run by the system during the first three minutes of operation.
- c. AUTO – In this position, the radar operational mode is controlled via commands from the NAS. All radar modes except BCN can be commanded, depending on the Master Mode switch and the weapon programme as shown in Table 7-19.
- d. AIR – AIR commands the radar to operate in the air-to-air modes, initially entering Air Search.
- e. GM – GM commands the radar to the Ground Map mode.
- f. BCN – This mode provides the operator with a PPI-type presentation displaying a coded reply or replies from beacons with specified characteristics.

g. SEA 1 – this mode is optimised for ship detection in low sea state environments. A zero velocity detection capability is provided on a B-Scan presentation with a X2 and X4 expanded display available.

h. SEA 2 – this is a moving target indicator (MTI) Mapping mode which uses a clutter notch to reject back ground clutter, and improve detection capability in high sea states. The presentation is B Scan with a X4 expanded display available.

Range Scale

7.159 This 4-position switch is used to select the maximum display range in nautical miles. The ranges available are 10/2.5, 20/5, 40/10, and 80/20. The first value in each case is for Air Search and unexpanded GM, BCN, and SEA modes. The value following the slash mark indicates the range extent displayed when expanded GM, expanded BCN, and expanded (X4) SEA modes are selected. The range extent in the X2 SEA 1 mode will be half of the selected range scale. The display range selected is indicated at the top left of the radar DU immediately prior to the operating mode.

Pulse Repetition Frequency

7.160 A 3-position toggle switch is used to manually select the PRF in air search only. The three positions are:

- LOW – The bottom position of the switch selects a low PRF which is normally used in relatively clutter-free environments (uplook).
- NORM – The centre position enables automatic PRF selection (low or medium) dependant upon antenna elevation angle and clutter levels.
- MED – The top switch position selects a medium PRF which is used normally in “downlook”

situations where clutter rejection and elimination of slow moving ground targets are desirable.

Azimuth Scan

7.161 A 3-position toggle switch is used to select the antenna azimuth scan width (AZ SCAN) except in ACM, AGR and MTT. Table 7-20 shows the azimuth scan coverage for various ranges. The antenna azimuth marker on the radar DU moves back and forth between the azimuth scan limits to indicate the antenna azimuth position.

- ± 60 – The bottom switch position allows selection of the full 120 degree azimuth scan coverage. To indicate a ± 60 deg azimuth scan, the azimuth marker drives 10 degrees past the last index mark (which represent 50 degrees). In the expanded map modes, the radar will only complete the azimuth scan width required to fill out the expanded display. In both the unexpanded and expanded SEA modes the B Scan display represents 120 deg of azimuth.
- ± 30 – The centre switch position allows selection of a 60 degree antenna azimuth scan pattern which is centred about the acquisition corral (Air Search and SAM) or the radar cursors (GM), and which can be placed anywhere within the gimbal limits of the antenna. In unexpanded SEA modes, only one half of the DU is covered, and in the expanded modes, the entire DU is covered. If the 60 deg scanned sector is against the gimbal limit, further movement of the corral/ cursor toward the gimbal limit will not reduce the size of the scanned sector.
- ± 10 – The top switch position allows selection of a 20 degree antenna azimuth scan pattern which operates as for the ± 30 AZ SCAN. In the unexpanded SEA modes the scan covers one sixth of the DU.

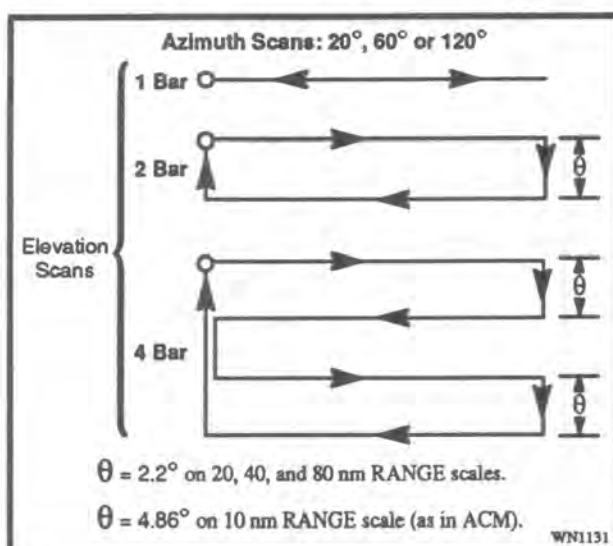
Table 7-19 Radar Mode Selection

RCP MODE SWITCH	----- MASTER MODE SWITCH -----			
	A/G		NAV	A/A
	--- WEAPON DELIVERY MODE ---			
	CCIP, DVTS, PLTS	MRTS		
AUTO	<u>AGR</u> / GM	<u>SEA1</u> / SEA2	<u>GM</u> / AGR	<u>ACM</u> / AIR
AIR	<u>AGR</u> / GM	<u>SEA1</u> / SEA2	AIR	<u>ACM</u> / AIR
GM	AGR / <u>GM</u>	<u>SEA1</u> / SEA2	GM	<u>ACM</u> / AIR
BCN	AGR / <u>BCN</u>	<u>SEA1</u> / SEA2	BCN	<u>ACM</u> / AIR
SEA 1	AGR / <u>SEA1</u>	<u>SEA1</u> / SEA2	SEA1	<u>ACM</u> / AIR
SEA 2	AGR / <u>SEA2</u>	SEA1 / <u>SEA2</u>	SEA2	<u>ACM</u> / AIR

Table 7-20 Antenna Scan Coverage

Vertical Coverage in Feet			
Elevation Scan			
Range	1 Bar	2 Bar	4 Bar
10 nm	4824	9968	20193
20 nm	9648	14308	23611
40 nm	19295	28616	47222
80 nm	38591	57232	94444

Azimuth Scan in nm			
Range	$\pm 10^\circ$	$\pm 30^\circ$	$\pm 60^\circ$
10 nm	3.5	10	17.3
20 nm	7.0	20	34.6
40 nm	13.9	40	69.3
80 nm	27.8	80	138.6

**Figure 7-17 Antenna Elevation Scan Patterns In Air Search****Elevation Bar**

7.162 This 3-position toggle switch allows selection of the antenna scan pattern in elevation when in Air Search and SAM only. Available scan patterns are 1-Bar, 2-Bar and 4-Bar. The movement of the antenna elevation and azimuth markers will show both antenna position and the type of scan. Figure 7-17 shows the three elevation scan patterns that are available. Table 7-20 shows the elevation scan coverage for various ranges.

Target History

7.163 The 4-position rotary Target History switch (TGT HST) is used to determine the number of target histories

displayed when in Air Search and SAM (not the target diamond). Up to four frames of target histories can be displayed depending on the switch position. A frame is defined as a single, complete traversing of the antenna through the selected scan pattern.

Freeze

7.164 The TGT HST switch can be pressed and released to initiate the freeze (FRZ) capability for all air-to-surface and BCN modes.

7.165 When FRZ is initiated, the radar video is no longer updated; the display image is essentially static. Except in MTT (where the FRZ function is inoperative), there is no transmission of RF, although the antenna continues to scan. An aircraft symbol (or "ownship bug") is generated by the radar and positioned by commands from the NAS so as to overlay the portion of the video map which is directly beneath the aircraft. Aircraft magnetic ground track at the time FRZ was pressed is shown in the bottom right corner of the DU.

7.166 The cursors can be moved within and off the display limits while the image is frozen. (Normally, in the non-freeze DBS and expanded freeze modes the map data moves and the cursors remain fixed at the centre of the display).

7.167 Freeze is deselected by pressing and releasing the TGT HST rotary switch a second time.

Altitude Line Tracker/Blanker

7.168 In Air Search, SAM, and ACM search, pressing FRZ will alternately enable and disable the Altitude Line Tracker/Blanker (ALT). At radar turn-on, ALT operation is disabled. The ALT is a feature that will indicate where false ground returns stemming from sidelobes could occur (the altitude line). When enabled, the ALT causes the aircraft bug (+) to appear adjacent to the range scale at the right edge of the DU. If the ALT is tracking the altitude line, the bug will appear at the point along the range scale which is the altitude above terrain in nautical miles i.e. targets at this range are likely to be ground clutter. If the ALT is not tracking the altitude line, the bug appears at the top (maximum range) of the range scale. If the ALT is disabled, the bug does not appear on the display. The Altitude Line Blanker, available in SAM and ACM search, blanks a 2500 ft window around the system altitude and effectively prevents altitude line returns from cluttering the DU. In ACM, the Altitude Line Blanker is always employed.

Channel Select

7.169 The Channel Select switch labelled CHAN/MK INT is a two-axis switch that controls the radar's operating frequency in all modes except Beacon.

7.170 In all air-to-air radar modes, Automatic or Manual channel selection is available. At radar turn-on, the radar enters Automatic with the initial channel set by the CHAN/MK INT switch position. Thereafter, frequency is selected by the radar and displayed as a dimly lit symbol (I, II, III, or IIII, respectively) in the lower right corner of the DU.

7.171 Manual channel selection is enabled by pressing the switch prior to rotating it. The DU symbol will be brightly lit. Rotating the switch to a channel position without pressing it, re-enables Automatic and specifies the radar's initial frequency.

7.172 Automatic channel selection is not available in A/G modes. The channel can be selected by either pressing and rotating the switch or simply rotating it.

Marker Intensity

7.173 The Z-axis of the CHAN rotary switch, marked MK INT is a momentary switch which, in conjunction with the SYMBOLOGY intensity control on the DU soft keys, allows variation of range marker intensity in the GM and BCN modes. There are four intensity setting levels available. At radar turn-on range marks will be the same intensity as other symbols. Each press of the MK INT will decrease the intensity by one level until the lowest level is reached, upon which the next press will select the brightest level.

7.174 The radar will remember range mark intensity from a prior A/G setting when, during the same "power on" interval, an A/G submode is again selected.

Moving Target Rejection

7.175 In all air-to-air radar modes, MK INT also controls selection of the narrow, normal or wide notch/doppler correlator. This Moving Target Rejection (MTR) capability causes the radar to reject targets whose ground speed along the antenna line of sight is less than either a narrow (35 knot), normal (55 knot) or wide (80 knots in Search, STT and SAM; 110 knots in Acquisition and ACM) limit. At radar turn-on, normal notch is enabled. Each press of MK INT will alternate from Normal notch to Wide to Narrow and back to Normal. An "H" will be displayed in the upper left corner of the DU when Wide notch is enabled, and an "L" for Narrow notch. No character is displayed for Normal notch.

NOTE

Because the 80 knot Wide notch will reject or reduce the chance of detecting some higher speed targets of operational interest, it should be used only when the volume of ground traffic displayed by the radar is very heavy and is masking true radar returns.

In general, the lowest notch that produces an acceptable false alarm rate should be used.

Acquisition Window and Tracking Gate Selection

7.176 Whenever the Radar mode is either SEA 1 or SEA 2 or the radar has entered MTT, the two top right hand keys on the radar DU are used to toggle the acquisition window and tracking gate options.

7.177 The left hand key will have an "A" displayed immediately adjacent to it to signify that the key will toggle the acquisition window. Either an N (Narrow) or a W (Wide) will be displayed next to the A to indicate the size of the Window.

7.178 The right hand key is labelled with a T (Tracking Gate) and will also have either an N (Narrow) or W (Wide) to indicate the Tracking Gate size.

Symbology Intensity Control

7.179 When radar video is displayed, the two DU soft keys at the top of the right hand column of keys control the eight levels of symbology intensity of the Radar Display. Toggling the upper key will increase the symbology intensity. Repeated selection of this key will eventually set the intensity to its maximum value, where continued toggling will have no further effect. The lower key will decrease the symbology intensity.

7.180 These keys are unlabelled and will control the symbology intensity in all air-to-surface radar modes.

7.181 The selection of various levels of symbology intensity also influences the Range Marker Intensity dependent upon the MK INT selected on the RCP.

Raster Symbology Brilliance Control

7.182 The Raster Symbology Brilliance Control located on the right side of the UFC is a rotary potentiometer that controls the brightness of the CIU generated radar symbology on the DU.

Radar/Fix Switch

7.183 The control stick mounted Radar/Fix switch is a 5-position toggle switch, three of which (fore, aft, and right) are used to control radar functions/modes. The left position is used to identify the over-flown position to the NAS. The switch is spring-loaded to the central position.

Designate Function

7.184 The forward position of the Radar/Fix switch initiates the designate function as follows:

- a. In Air Search and SAM, initiates track of a specific target; in ACM selects Boresight ACM; and toggles between STT and SAM if tracking parameters allow.
- b. In A/G modes, designates the ground coordinates of a target or IP based either on the line-of-sight of the appropriate HUD symbol or on the radar cursors, (Table 7-21).
- c. In NAV mode, designates either the appropriate HUD symbol or radar cursors either as a markpoint or as the coordinates of the update point (Table 7-21).
- d. In SEA modes, initiates MTT.

7.185 Table 7-21 lists the specific designate functions for each A/G weapon delivery mode.

Return to Search

7.186 The aft position of the Radar/Fix switch commands the return-to-search function (RT SRH) as follows:

- a. In air-to-air modes, pressing RT SCH when a target is being tracked causes a break lock and return

to the previous search pattern. In ACM, if a target is not being tracked, RT SCH will cause a change in the scan pattern.

b. In GM when the range scale is 40/10 or 80/20, RT SCH will alternate between expanded GM and GM. When the range scale is 10/2.5 or 20/5 RT SCH alternates between GM, expanded GM, and DBS.

c. For BEACON mode, RT SRH is used to select, alternatively, the expanded and unexpanded submodes.

d. In the SEA Modes the selection of RT SRH has the following effects, as shown in Figure 7-18.

1. From an unexpanded B Scan SEA 1, RT SRH will alternate between expanded x 2, expanded x 4 and return to the original unexpanded display.

2. In SEA 2 mode, RT SCH alternates between unexpanded and expanded x 4 displays.

3. Whenever the Radar is in the MTT mode, selection of RT SRH will cause the radar to return to the display from which the MTT was entered.

Table 7-21 Designate Switch Functions

DESIGNATE SWITCH				
	<u>NAS MODE</u>	<u>RADAR MODE</u>	<u>DESIGNATES</u>	<u>AS COORDINATES OF:</u>
A/G	CCIP	All modes	No function	-----
	DVTS	All modes	HUD Aimpoint	Target
	PLTS (I Pt Dest)	AGR	HUD 	IP
	PLTS (I Pt Dest)	GM, BCN, S1, S2	HUD  & Radar Cursors	IP
	PLTS (I Pt Not Dest)	AGR	HUD 	Target
	PLTS (I Pt Not Dest)	GM, BCN, S1, S2	HUD  & Radar Cursors	Target
	MRTS	S1, S2	HUD  & Radar Cursors (& initiates radar acquisition/lock on sequence)	Target
NAV	UPDT-RDR	GM, BCN, S1	HUD  & Radar Cursors	Update Point
	UPDT-RDR	AGR, S2	No function	-----
	UPDT-(HUD)	All modes	HUD 	Update Point
	MRK-RDR	GM, BCN, S1, S2	HUD  & Radar Cursors	Mark Point
	MRK-RDR	AGR	No function	-----
	MRK-(HUD)	All modes	HUD 	Mark Point

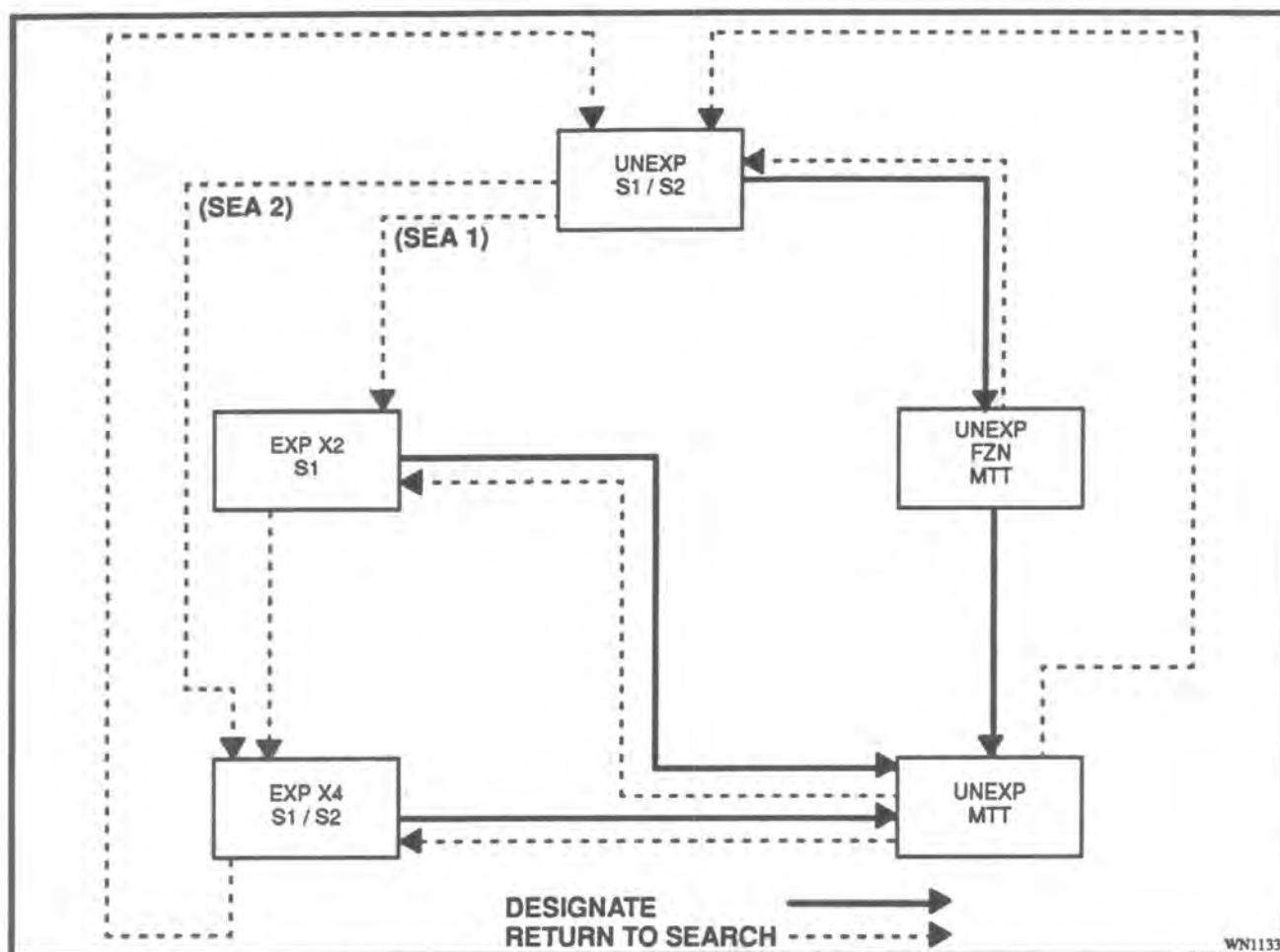


Figure 7-18 Sea Mode Return to Search/Designate Flow Chart

Radar Mode

7.187 Toggling the Radar/Fix switch to the right alternates between radar modes that are available as listed in Table 7-19.

Slew Control

7.188 The throttle mounted Slew Control is used to slew the acquisition corral in Air-to-Air modes, and the cursor in GM, BCN and SEA modes. Applying left-right and up down pressures to the control causes movement of the acquisition symbol/cursor in azimuth and range, respectively, and (if appropriate) changes the antenna scan pattern location relative to the aircraft.

Antenna Elevation Control

7.189 The antenna elevation angle is positionable over a ± 60 deg range through the throttle mounted ANT ELEV control. In GM, BCN and SEA modes the antenna elevation is automatically computed around the intersection of the cursors. The antenna elevation control is used to make manual adjustments.

NOTE

Both the MIN and MAX search altitudes (controlled by the NAS) on the DU will limit at

zero when the ANT ELEV control on the Throttle Grip is rotated far enough to yield a search request below mean sea level.

Radar Gain Controls

7.190 In the Air-to-Ground mapping modes, the radar gain is controlled by both the RADAR RECEIVER GAIN control on the NAS Panel (coarse adjustment) and the gain control on the Throttle Grip (fine adjustment). In these modes the fine gain control adjusts approximately 25% of the gain around the NAS Panel gain setting. In addition, in DBS and SEA 2, maximum backward rotation of the throttle gain control results in maximum IF gain independent of the GAIN adjustment on the NAS Panel.

RADAR DISPLAYS

7.191 Radar data may be presented on either the right or left DU based on pilot selection. Radar parameters are also displayed on the HUD in ACM and SEA modes. Figure 7-19 shows the scales that are used on the displays. Figure 7-20 shows and explains all symbology used for all Air-to-Air modes. Figure 7-21 shows the basic Air-to-Ground display symbology.

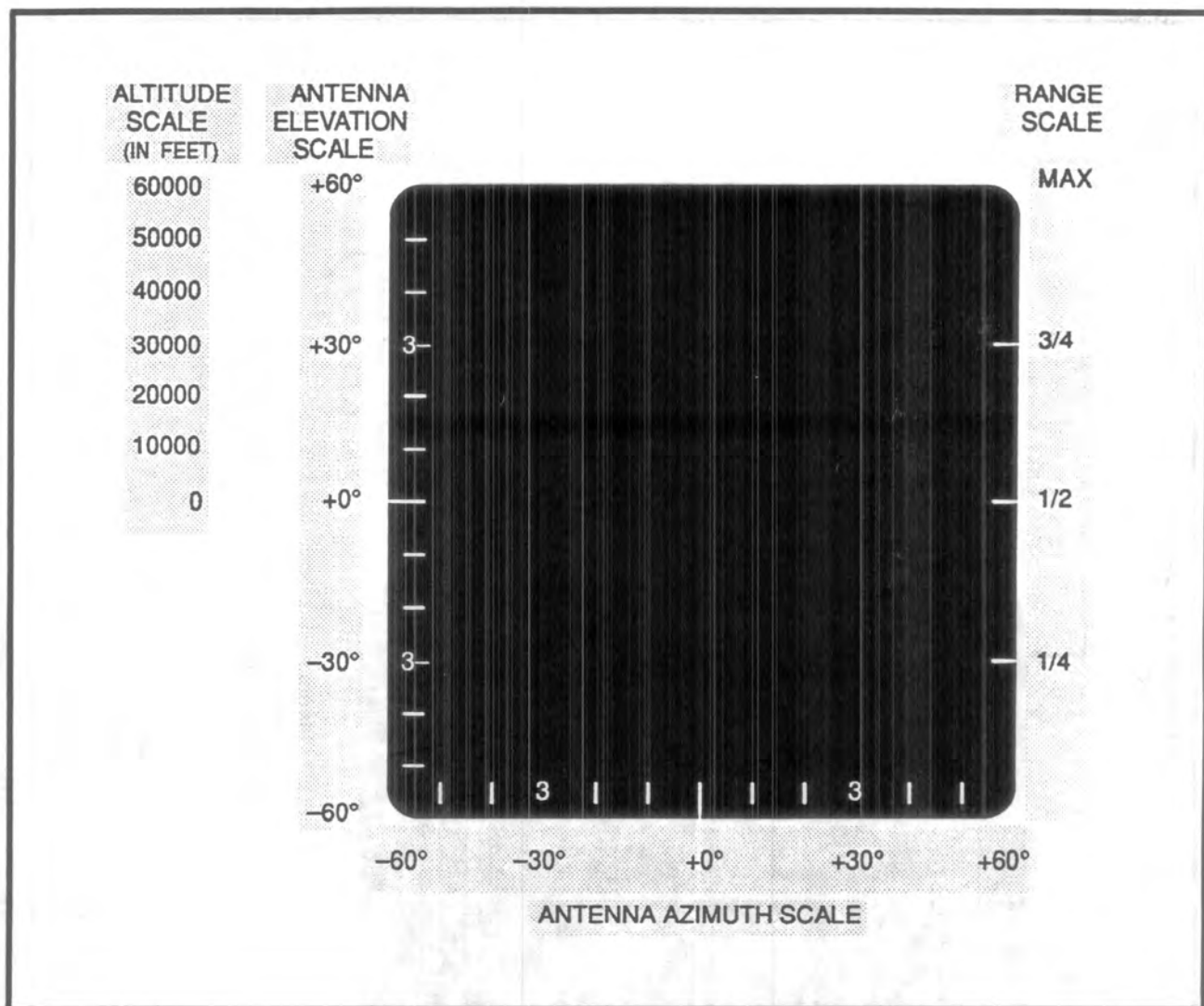


Figure 7-19 Air-to-Air Mode Scales

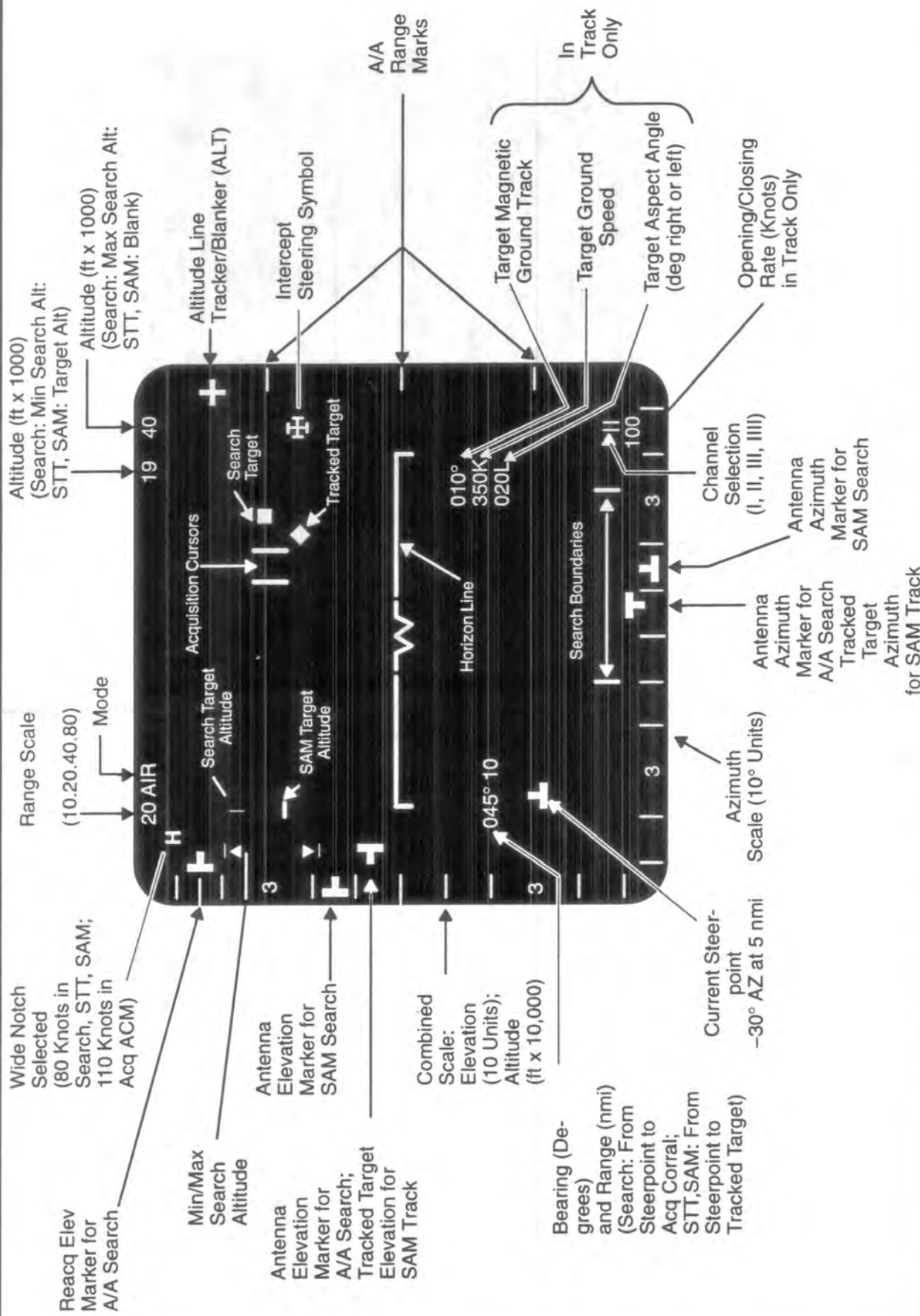


Figure 7-20 Air-to-Air Display Unit Symbolology

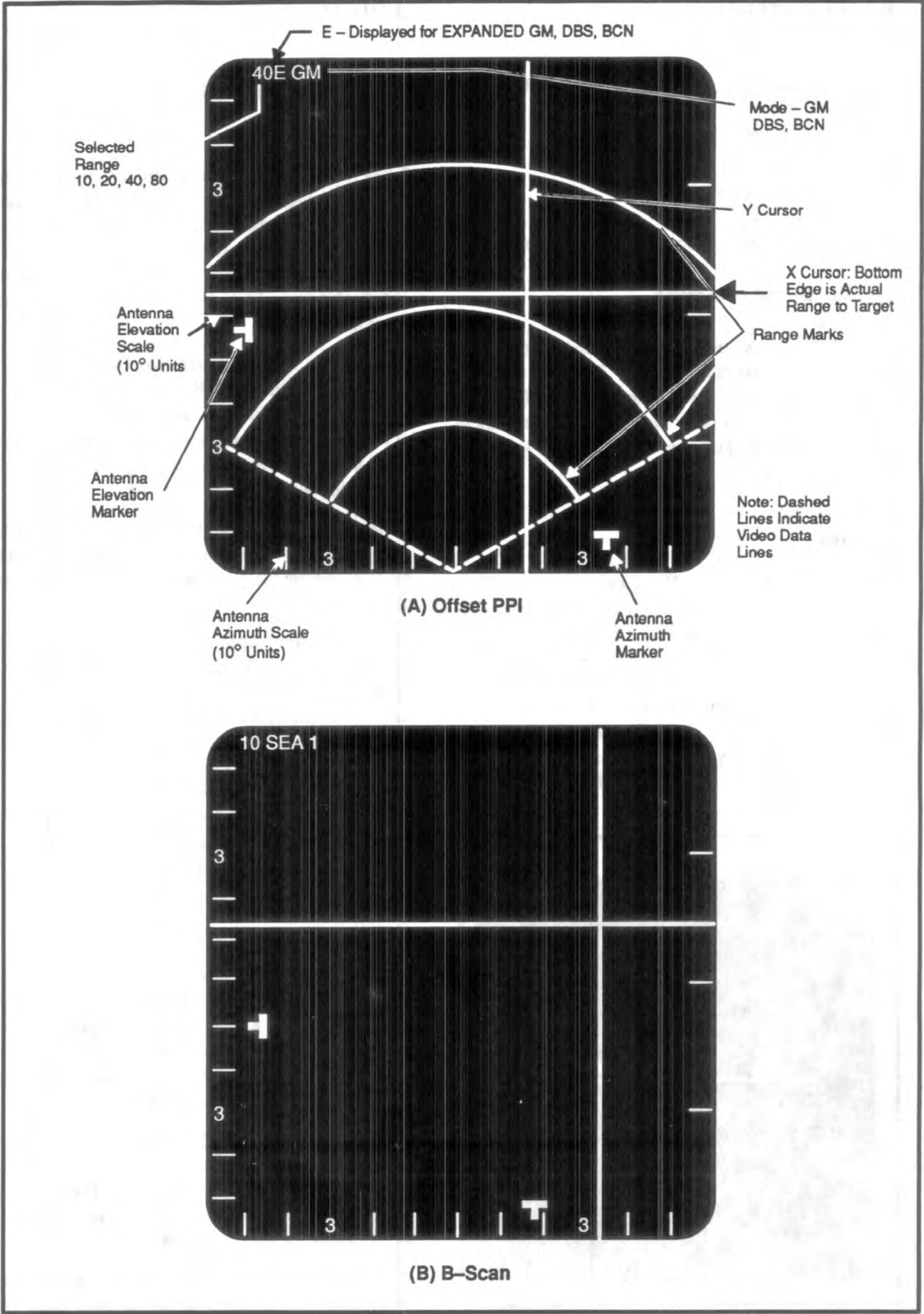


Figure 7-21 Air-to-Ground Display Unit Symbology

RADAR MODES

7.192 The operating radar mode is determined by:

- the RCP MODE switch,
- the Master Mode switch,
- the selected A/G weapon delivery mode, and
- the Radar/Fix switch.

7.193 The position of the Master Mode switch will override all other selections. Table 7-19 lists the radar mode as a function of these switches/modes. For those conditions where two radar modes are indicated, these modes are obtained alternately by toggling the Radar/Fix switch to the right.

Standby

7.194 Whenever the RCP MODE switch is in the STBY position, the Standby display is present on the radar DU. There is no video displayed; the antenna azimuth and elevation markers indicate the antenna "stow" position of 0 degree azimuth and 60 degree up; and the alpha-numerics at the top left corner of the display indicate the selected range scale and "STB" for the mode. The horizon line indicates aircraft roll and pitch angles. Figure 7-22 shows the standby mode display format.

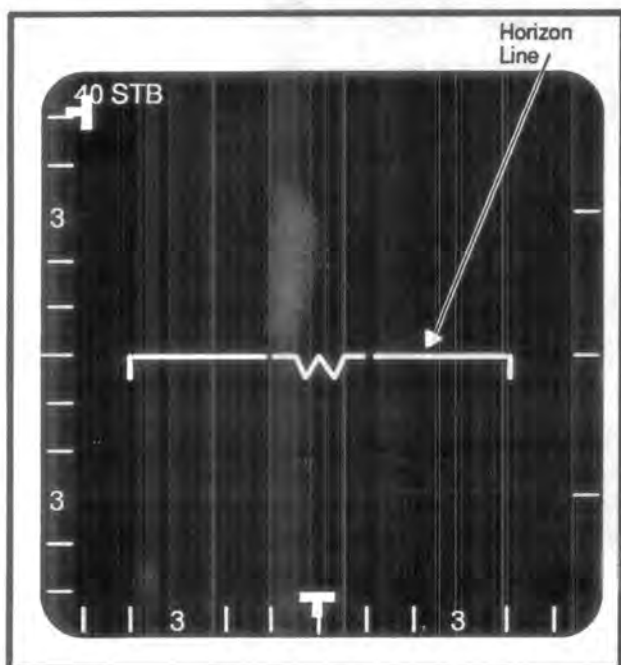


Figure 7-22 Standby Mode Format

AIR-TO-AIR MODES

7.195 The relationships between the available air-to-air modes is shown in Figure 7-23.

Air Search

7.196 The Air Search mode is used for detecting airborne targets at ranges selectable by the operator. Any targets detected by the radar will be displayed as squares at the appropriate range and azimuth relative to the aircraft in a space stabilized coordinate system. The radar can detect and display up to 64 targets at any one time (including target histories).

7.197 Range scale switching may be accomplished by either using the RCP RANGE switch, or by positioning the acquisition symbol in range. Slewing the acquisition corral to 95% of the present range scale will switch the range scale to the next highest range and slewing to 5% will switch to the next lower range.

7.198 When returning to Search from STT or SAM, a reacquisition elevation marker will be positioned against the altitude scale for 10 seconds to indicate the last known target elevation.

7.199 Any search target's altitude, shown as a vertical bar against the altitude scale, can be obtained during Search mode by placing the acquisition symbol around the desired target. The centre point of the bar represents target altitude.

NOTE

The accuracy of the target altitude display can be improved by selecting Target History 2, 3, or 4, and a 2-bar or 4-bar elevation scan pattern.

Acquisition

7.200 The acquisition mode to initiate radar track of a specific target is carried out by pressing and releasing DESIGNATE with a target within the acquisition corral. One such press and release (a "single designate") causes the radar to enter SAM. With two successive movements (a "double designate"), the radar enters STT.

7.201 When DESIGNATE is pressed, the antenna will begin a 4-bar ± 10 deg azimuth spotlight scan, the centre of which can be controlled as in Air Search. This scan pattern will continue as long as DESIGNATE remains pressed. All targets within the scan pattern will be displayed.

7.202 Upon release of DESIGNATE, the radar will begin the acquisition sequence on the first target detected within the acquisition corral. If there are no targets within the acquisition corral, the radar system will immediately return to the commanded search mode.

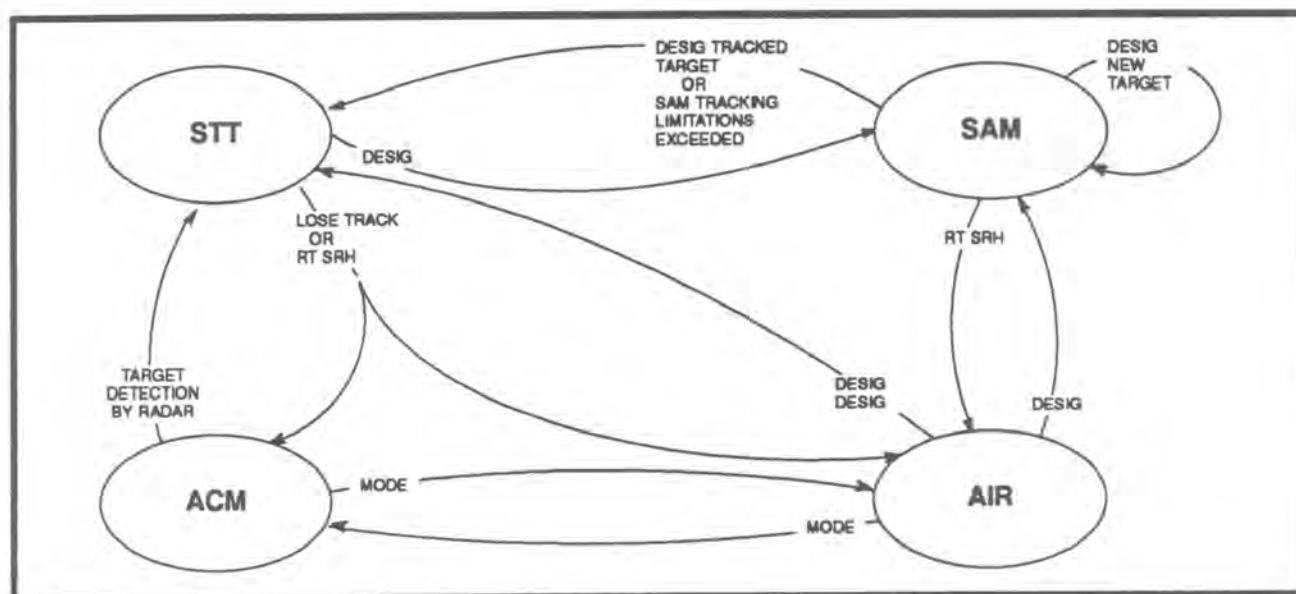


Figure 7-23 Air To Air Radar Mode Selection

Single Target Track

7.203 The radar enters Single Target Track (STT) mode in one of three ways:

- From Air Search, by double-designating a target, or automatically when attempting to enter SAM by single-designating a target but target parameters prevent SAM tracking.
- From SAM manually by single-designating a target, or automatically when the SAM tracked target approaches the clutter notch, closes to within 3 nm range, or would otherwise have been lost if SAM were maintained.
- From ACM search automatically when a target is acquired.

7.204 When STT is successfully established, track data appears, search symbology is removed, and the target symbol changes to a diamond. Automatic switching to the next higher or lower range scale will occur when the target range is 95% or 45% of the present range scale respectively. A track-through-the-notch feature has been added to allow active target tracking through the clutter notch when the target amplitude is sufficiently large relative to the clutter amplitude.

7.205 Indications that the system is about to lose track, and that the radar is attempting to re-acquire the target, is given by a rapid helical mini-scan about the target, and the reappearance of the ALT. If the radar loses track, or RT SRH is pressed to "break track", the system will revert to Air Search and display the reacquisition elevation marker.

7.206 During the attempt to change from STT mode to SAM, using the DESIG switch, the radar remains in STT when target parameters prevent SAM tracking.

Situation Awareness Mode

7.207 Situation Awareness Mode provides an interleaved search/single target track capability in which the radar tracks the acquired target for a short interval, searches a zone controlled by the pilot around the acquisition corral, and then returns to tracking the target.

7.208 SAM is entered from Air Search or STT by single designating an acquired target, and only if the selected target's parameters lie within SAM's capabilities. If the parameters are such that the target cannot be tracked in SAM, the radar instead enters or remains in STT. Examples of situations that result in STT entry include a target that is too small, a target at long range, a target closer than 3 nm, a target near the main beam clutter notch, and a target data fade.

7.209 The scan pattern is centred around the acquisition corral and the tracked target's elevation. While the pattern is selectable, the actual scan width, as shown by the scan boundary markers, may be less than the maximum and varies with the tracked targets geometry and the number of bars selected.

7.210 Target histories and MTR are selectable for search targets only. No target histories are shown, and the 55 knot notch is implemented for the tracked target.

7.211 The DU's range scale does not automatically change with the target diamond but can be manually changed either from the RCP or by moving the acquisition corral as in Air Search. The tracked target will flash at the top of the DU to indicate that the target's actual range exceeds the selected range scale.

7.212 STT can be entered from SAM by designating a tracked target in the acquisition corral, or it will occur automatically if the target approaches the clutter notch, closes to 3 nm, or would otherwise be lost if SAM were maintained. When RT SRH is pressed, the radar enters Air Search.

7.213 An automatic cursor-track feature is enabled in SAM which allows entry to STT on the SAM tracked target, using DESIG, without positioning the cursor. This feature is disabled when the slew control is moved.

7.214 The track-through-the-notch feature is not available in SAM. When the target enters the clutter notch, SAM coasts until either the target emerges from the notch or the target-lost time exceeds 5 seconds, whichever comes first.

Air Combat Mode

7.215 ACM is initiated by selecting A/A on the Master Mode Switch and features automatic acquisition, lock-on, and track of the first target detected as the antenna follows its scan pattern. The range scale will be 10 nm and upon acquiring a target, the radar will enter STT.

7.216 In ACM Search, no acquisition corral is displayed, and prior to lock-on, there will be no target symbols displayed. If more than one target is detected within the same beamwidth, the closest target in range is selected.

ACM SCAN PATTERNS

7.217 Four scan patterns are available in ACM search (target not tracked) as shown in Figure 7-25. The relationship between the scans is shown in Figure 7-24.

HUDACQ

7.218 When ACM is initiated, the antenna enters a 23 degree x 21 degree 4-bar scan pattern which approximates the HUD FOV. If the ALT is enabled, then the radar adds an extra bar to the pattern for altitude line processing. (Figure 7-25A).

VERTACQ

7.219 A vertical 3-bar, 13 degree x 44 degree scan pattern is available by pressing RT SRH. The bottom of the pattern extends down to approximately the centre of the HUD field of view. (Figure 7-25B).

Boresight

7.220 By pressing DESIG boresight is selected. The radar is thereby commanded to point along the ADL. Acquisition is inhibited until the switch is released whereupon automatic acquisition commences. (Figure 7-25C).

Sleuable ACM

7.221 Application of sufficient thumb pressure to overcome the dead zone of the slew control selects the roll-and-pitch-stabilized sleuable ACM scan pattern from any of the other three ACM patterns. This pattern is initially centred at 0 deg azimuth and elevation. The centre may be relocated within gimbal limits by means of the slew control. The centre of scan is displayed on the DU as an iron cross. The position of the scan is also presented on the HUD. (Figure 7-25D).

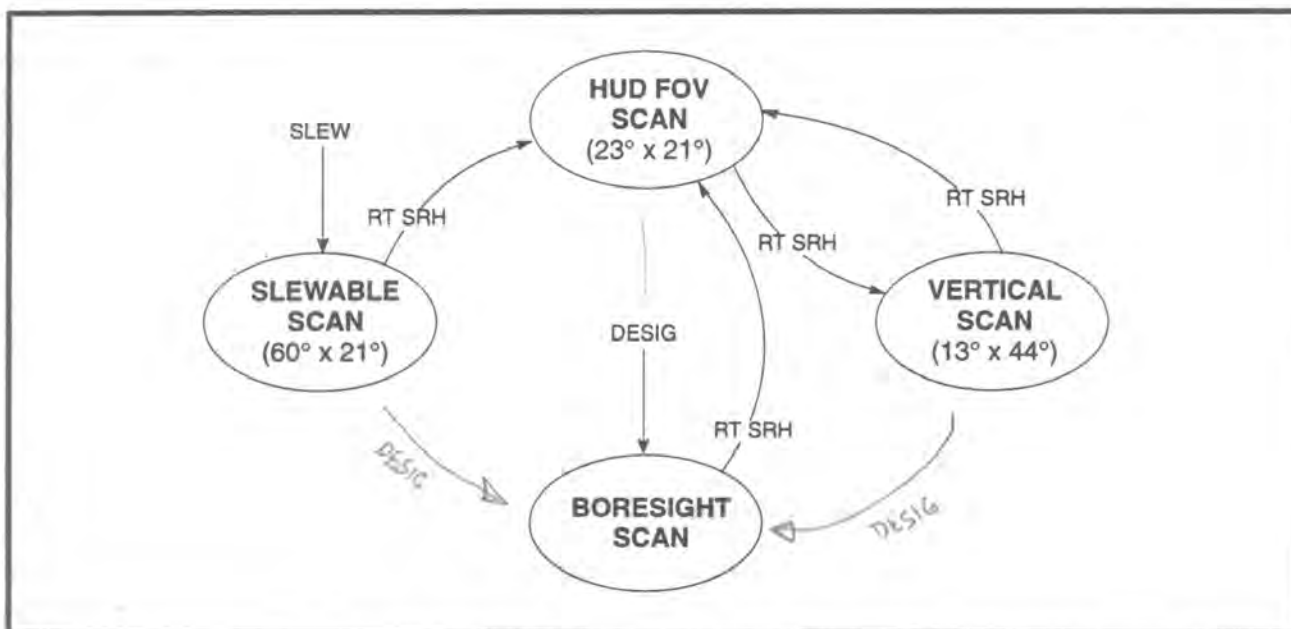


Figure 7-24 ACM Scan Patterns

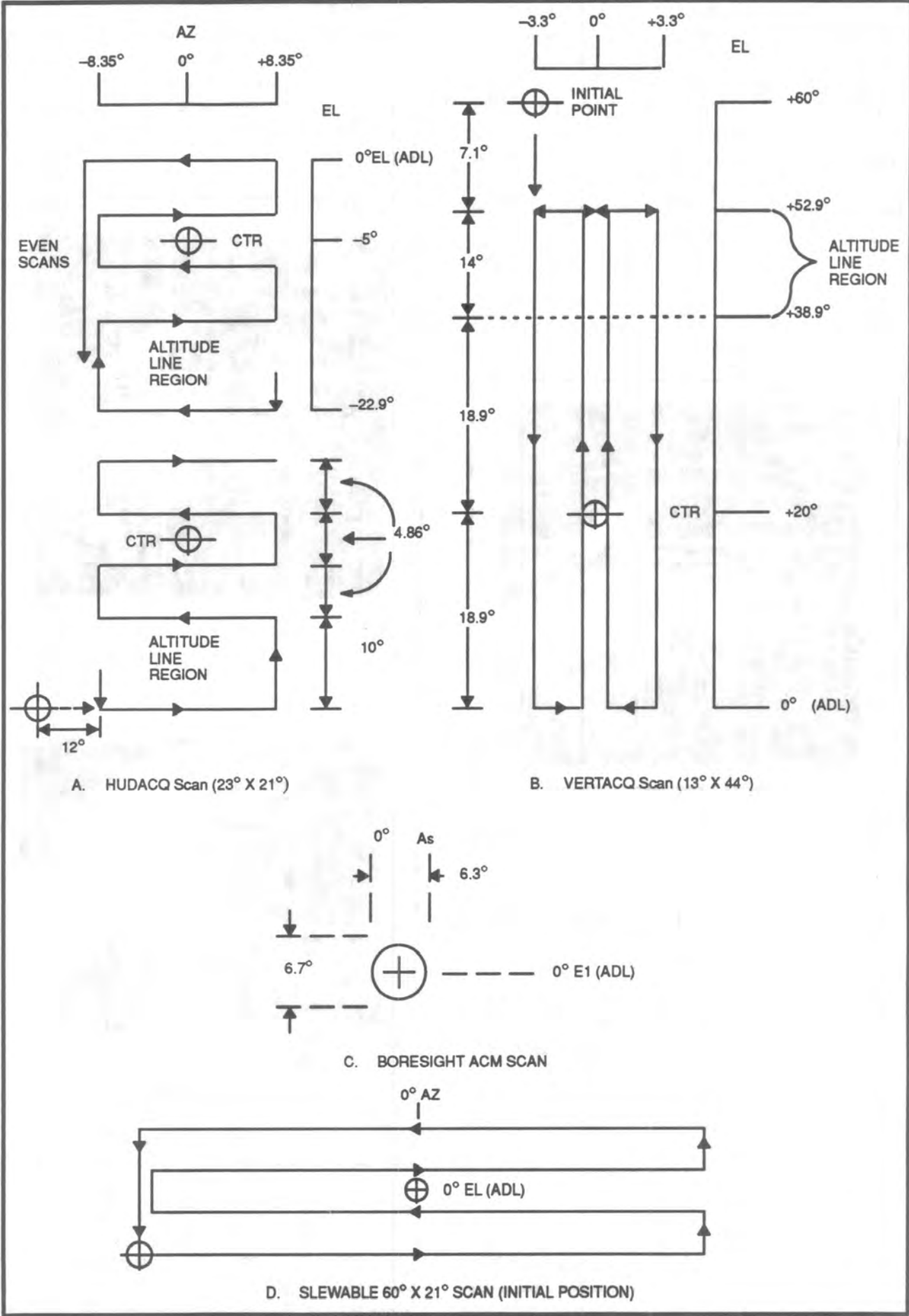


Figure 7-25 ACM Scan Patterns

7.222 When in ACM search, depressing RT SRH will return the radar to the 23 degrees x 21 degrees scan pattern, from any other scan pattern. Successive selections of RT SRH will alternate between 13 degrees x 44 degrees and 23 degrees x 21 degrees scan patterns. Pressing RT SRH when the radar is tracking a target will break track and return the scan pattern to the previously selected ACM search scan pattern. This switch therefore functions both as a scan selection switch and as a break track switch. When a target is rejected, or when track is lost for any reason, the radar will lock on to the next target that appears in the scan pattern.

7.223 To exit ACM, A/A Master Mode must be de-selected, or the Radar/Fix switch mode change operated to select Air Search.

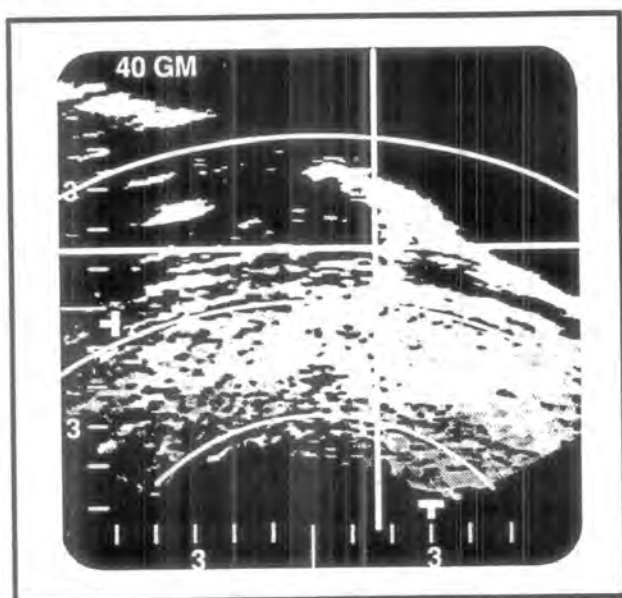


Figure 7-26 Typical Ground Map (GM) Display

AIR-TO-GROUND MODES

Ground Map

7.224 Ground Map (GM) provides an all-weather, PPI presentation utilising noncoherent, frequency agile, signal processing with a low PRF. A typical GM display is shown in Figure 7-26. A pencil beam is employed in azimuth and elevation, and the elevation scan is automatically limited to one bar. Manual IF gain control is provided. The antenna scan is roll, pitch and drift stabilized in that aircraft ground track represents 0 degree azimuth.

7.225 A four-to-one (4:1) map expansion feature, as per the dual numbers of the RANGE switch, is available. When initiated, by selecting RT SRH, it provides a patch-type map display (expanded PPI) centred about the cursor position. Unlike unexpanded GM, the cursors are fixed in

the centre of the radar display so that aircraft progress and movement of the slew control moves the map data under the cursor. The antenna azimuth scan limits are automatically set by cursor range so as to cover the horizontal map dimensions only; a narrower scan width (giving higher frame rate) may be selected however, using the AZ SCAN switch. A typical expansion is shown in Figure 7-27.

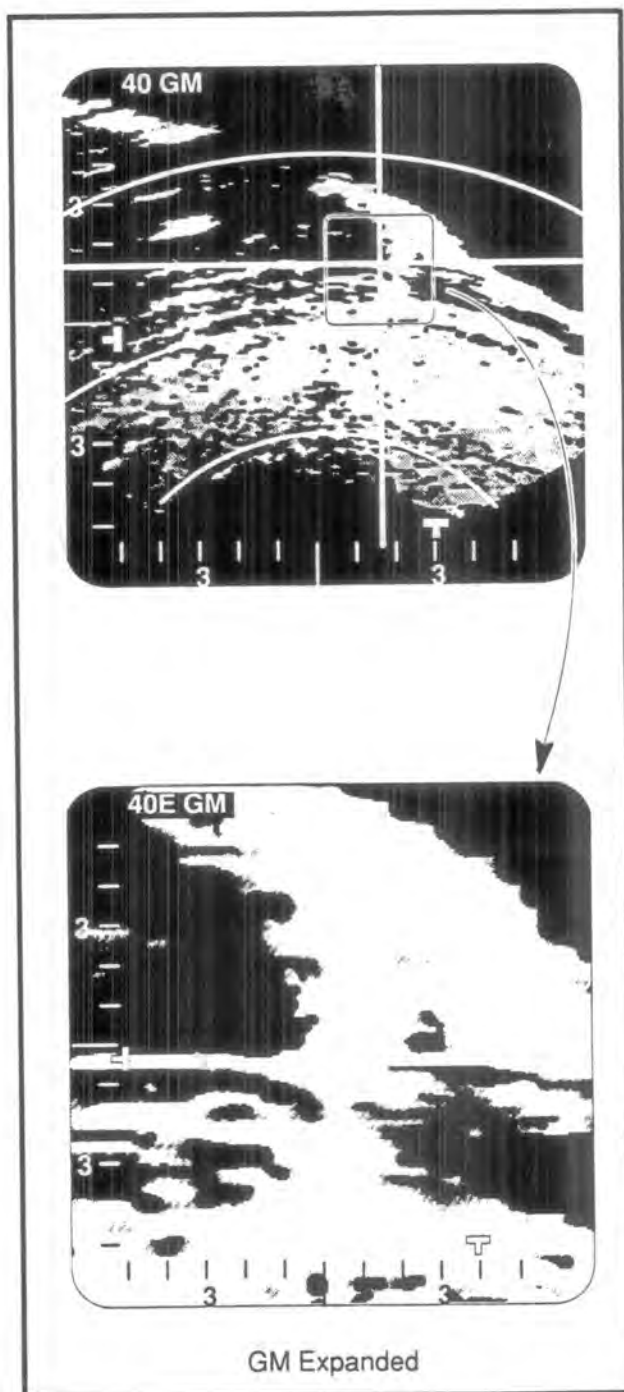


Figure 7-27 Typical Expand Operation

7.226 When the range scale is 40/10 or 80/20, successive selections of RT SRH alternately select unexpanded and expanded GM. The relationship between GM submodes is shown in Figure 7-28.

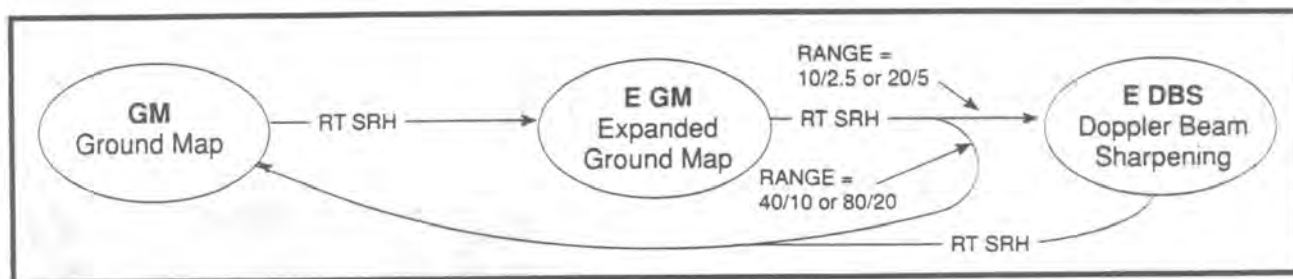


Figure 7-28 Ground Map Submodes

7.227 The Freeze mode is available in both expanded and unexpanded GM. When in Freeze mode the video is not updated. An ownship bug is shown on the map at the INU derived aircraft position. Aircraft magnetic track at freeze is shown in the bottom right corner. A typical GM Frozen display is shown in Figure 7-29.

7.228 On both unexpanded and expanded displays, the cursor intersection is ground stabilized during a markpoint or update procedure. On an unexpanded display, prior to slewing, the cursor intersection is fixed in the centre of the display and the map 'snowploughs'. As soon as slewing is activated the cursors become ground stabilized. 'Snowplough' can be regained by pressing the throttle undesignate switch.

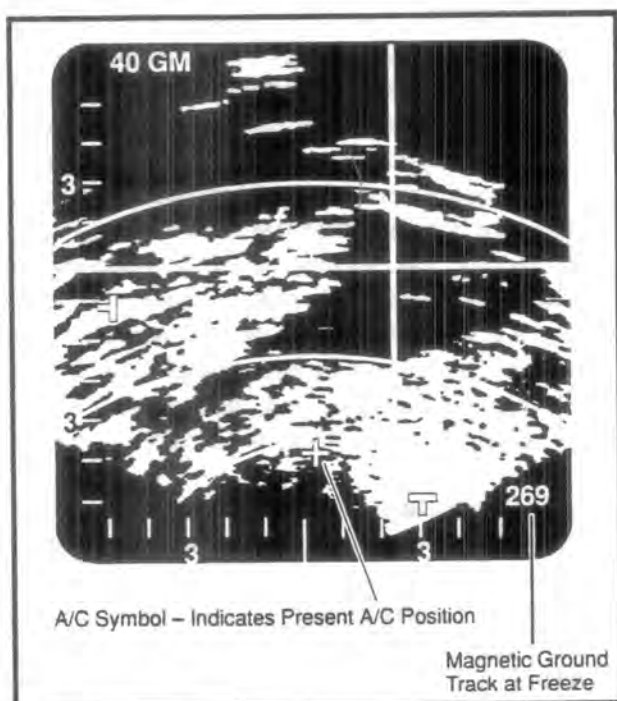


Figure 7-29 Typical Freeze Display

Doppler Beam Sharpening

7.229 The DBS submode of GM can be selected by pressing the RT SRH switch when the system is in the GM expanded mode and the RANGE scale is either 10/2.5 nm or 20/5 nm. Successive cyclings of RT SRH will alternately select unexpanded GM, expanded GM, and DBS. The DBS map provides improved azimuth resolution over the GM or

expanded GM for azimuth angles greater than ± 15 degree, on an expanded map display. Antenna scan and cursor control are the same as in the GM expanded mode. Freeze mode is available.

7.230 In regions of low clutter return, the map position may alternate between right-to-left and left-to-right scans. To stop the alternation, turn the Fine Gain to its maximum backward position for the minimum duration of 1-1/2 sweeps, then adjust both Gains to obtain the best map picture.

Beacon

7.231 BCN mode provides a capability for navigation fixtaking and weapon delivery relative to ground beacons, and tanker rendezvous using A/A beacons. The mode can only be selected manually via the MODE selection switch on the RCP.

7.232 The antenna scan coverage, PPI display, antenna elevation coverage, and control and display ranges are the same as in the GM mode. The cursors are positioned by the NAS based upon the fixed Beacon delay which is inherent in the Beacon, and are adjustable by the slew control.

7.233 The beacon response to an interrogation by the radar consists of time-coded pulses. The detected beacon return will be displayed on the DU in drift stabilized, PPI map format. Both unexpanded and expanded BCN display modes are available and are processed the same as GM mode.

7.234 There is no ground video presented in the beacon displays, but there is RF gain control. The coded beacon reply appears as one, two or three arcs normal to the radial extending from the vertex of the unexpanded display. The azimuth extent of the arcs increases with beacon replies of increasing strength and with increased range to the reply.

Air-to-Ground Ranging

7.235 Air-to-ground (AGR) provides real-time slant range measurements to a designated ground point measured along the antenna line-of-sight. It is not a selectable mode on the RCP, but is obtained as a function of the selected NAS mode and the mode change facility on the Radar/Fix switch.

7.236 The radar display for AGR is shown in Figure 7-30. The antenna azimuth and elevation are indicated relative to the aircraft body axes; there is no video, target symbology, or antenna sweep. The iron cross symbol, which is simply the intersection of a horizontal and a vertical line through the azimuth and elevation markers respectively, follows the NAS commanded antenna position. The diamond on the right side of the display appears at the antenna line-of-sight range to ground when AGR lock-on is present. If AGR is not locked-on, the diamond changes to a square.

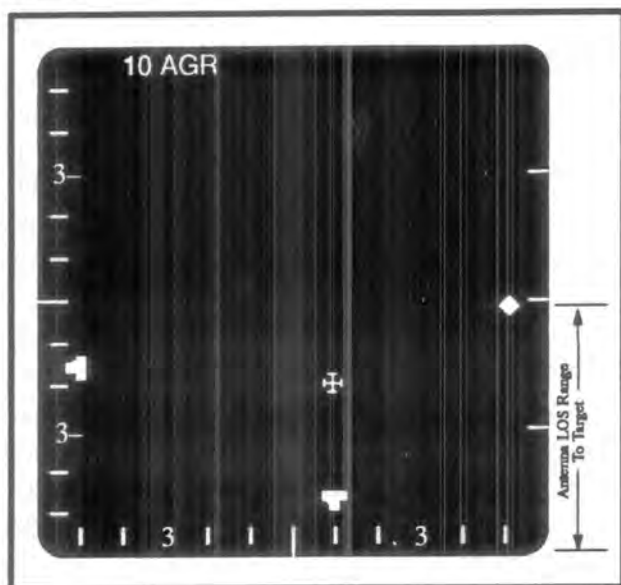


Figure 7-30 Typical Air-to-Ground Ranging (AGR) Display

SEA Modes

7.237 SEA 1/SEA 2 are B-Scan presented mapping modes designed specifically for detection of ships in sea clutter. SEA 1 is similar to GM but reduces the effects of background clutter. Frequency agility is used both in the SEA 1 mode and in the MTT mode to smooth the background clutter and enhance target visibility. SEA 2 is an MTI mapping mode which uses a clutter notch to reject background clutter. It can improve the detection capability of the radar in some situations at high altitudes and under very high sea states. A typical SEA 1 display is shown in Figure 7-31.

NOTE

SEA 2 should not be used in low clutter situations as it will reduce radar performance.

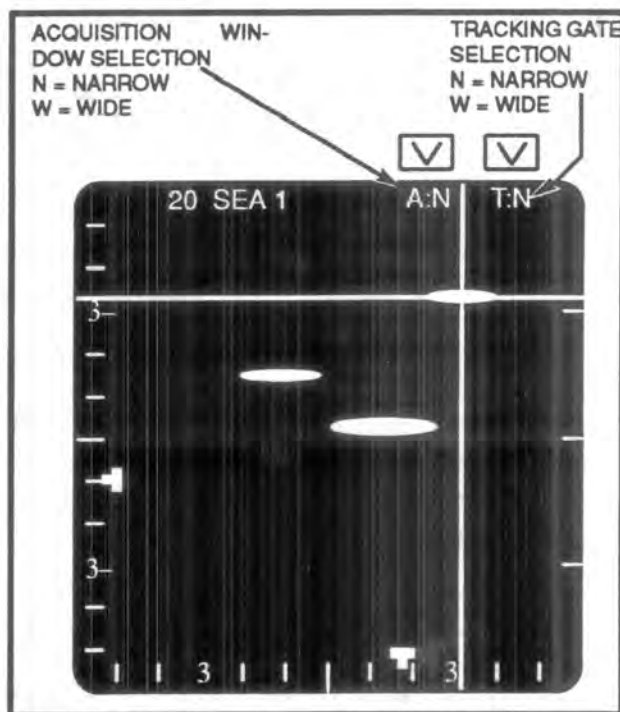


Figure 7-31 SEA 1 Mode Display

7.238 Both SEA 1 and SEA 2 are selectable from the RCP Mode switch, or by selecting a MRTS weapon programme. The antenna scan is stabilized in both roll and pitch. Both modes employ an automatic antenna tilt feature which uses altitude to adjust the antenna elevation for optimum performance. Antenna tilt should not be adjusted manually (unless the altitude is suspect) as errors of only 1–2 degrees in elevation can severely affect detection capability. Wherever the Antenna Elevation control is when SEA 1 or SEA 2 is selected, becomes the zero Antenna Elevation command position, i.e. the antenna angle is not affected by the Antenna Elevation control unless the pilot moves this control after SEA 1 or SEA 2 is selected.

7.239 The expanded modes provide improved resolution hence detectability by using a narrow radar pulse which reduces the background clutter competing with the target. x2 and a x4 expand capability is provided in SEA 1, and a x4 in SEA 2. The x2 mode covers half the selected range scale with half the pulse width, while the x4 expand mode covers $\frac{1}{4}$ of the range scale with $\frac{1}{4}$ of the pulse. Indication of the selected Expand mode is given following the range scale in the upper left corner of the radar display (E2 for x2 and E4 for x4). Figure 7-32 shows expanded mode displays.

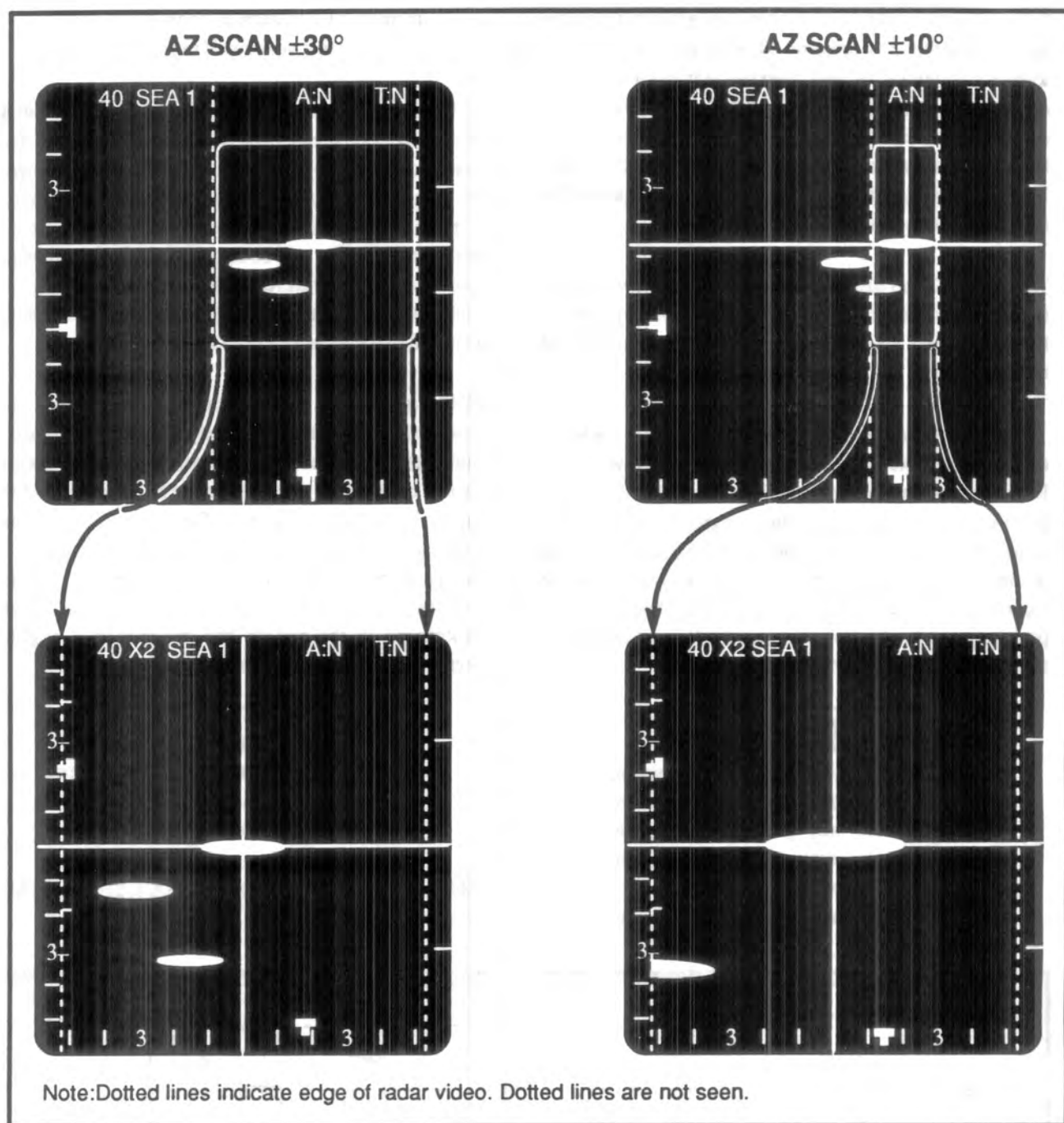


Figure 7-32 Expanded x2 SEA 1 Submode

7.240 The SEA Expand modes are entered from the unexpanded mode by pressing RT SRH. In SEA 1 RT SRH toggles through x2, x4, and Unexpanded; and in SEA 2 x4 and Unexpanded. In the Expand modes the current range coverage is indicated on the left side of the DU by two short horizontal lines scaled according to the selected RCP scale. Irrespective of AZ SCAN setting, the radar will use the full horizontal space available on the DU.

7.241 SEA 1 and SEA 2 can be used over land where the narrow pulse available in the expanded modes will reduce land clutter and SEA 2 will improve detection of ground moving targets.

7.242 A target detection is recognized in SEA 1 when a discrete target exceeds the background clutter levels by at least one grey level in the 13 different levels available. It is possible for a target and the clutter signal to appear at the same grey level and fail to be detected. Coarse adjustments in the SEA 1 gain controls the signal energy entering the receiver while fine adjustment of the gain about the gross position permits changing the grey scale quantization by about one level, as shown in Figure 7-33.

NOTE

In rough sea conditions the grey scale setting makes little difference in detection capability and only gross changes in the receiver are necessary. At low altitudes and calm seas, however, where there is only a small background return, the grey scale

adjustment becomes important and can be used to detect very small targets.

7.243 The SEA 1 display is distinctly different from any other map mode in that even in the absence of radar return there should always be a background noise level painted on the display. The display intensity must be adjusted correctly so that this background noise is visible or detection capability will be degraded. In SEA 2, if the gain is adjusted correctly there should be no visible background clutter painted on the display and gain should be adjusted to be just above the background clutter.

7.244 In SEA 2, under moderate to low sea state conditions the Clutter Tracker may be unable to acquire sea clutter at normal receiver gain settings. This causes the display background to be uniformly bright obscuring ship targets. If this happens, turn the Fine Gain to its maximum backward position for a minimum duration of 1-1/2 sweeps, then adjust both Gains to the desired brightness of ship targets. A normal SEA 2 display has a dark background in the middle and progressively brightens toward the ± 60 degree scan limits.

NOTE

If SEA 1 is selected after the Gain has been optimized for SEA 2, the clutter background will normally become excessively bright.

7.245 The relationships between SEA 1, SEA 2 and MTT are shown in Figure 7-34.

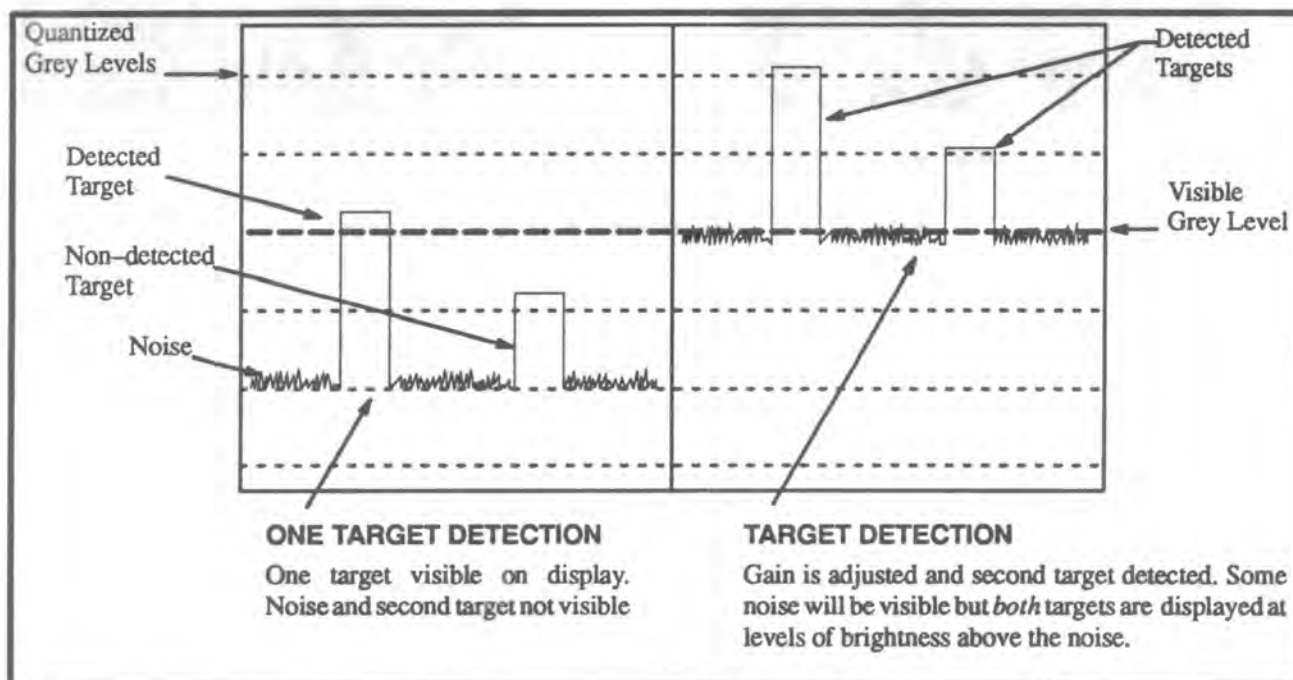


Figure 7-33 Gain Adjustment For Target Detection

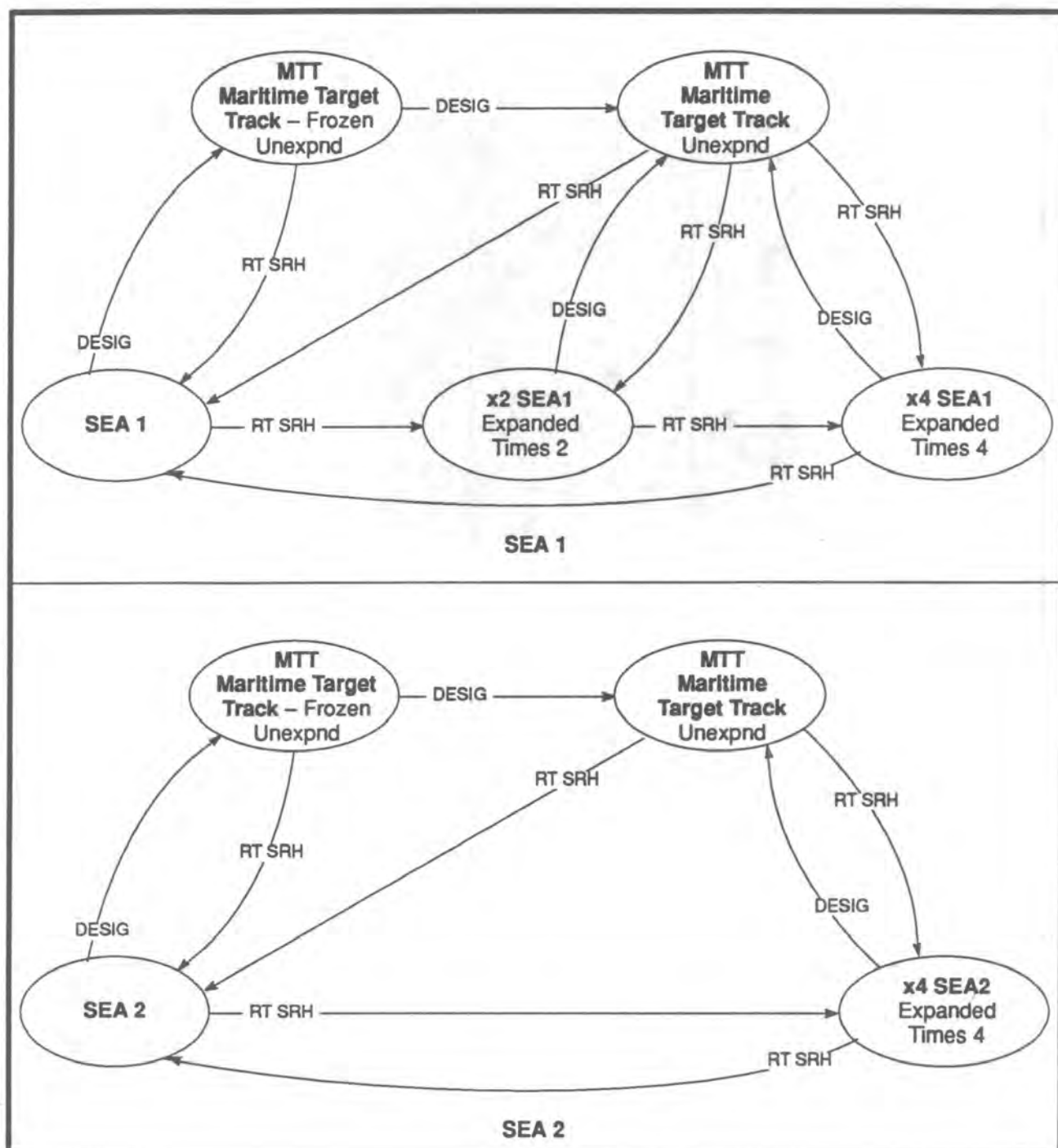


Figure 7-34 SEA 1 & SEA 2 Submode Selection

Maritime Target Track

7.246 The Maritime Target Track Mode (MTT) is designed to provide track type information on ship targets seen from either SEA 1 or SEA 2 modes. Acquisition of a SEA target is accomplished by designating a target under the cursor intersection. Exit from MTT back into the basic search mode is accomplished by pressing RT SRH. (See Figure 7-34).

7.247 Two display options are available which provide either an unexpanded frozen or unfrozen B-Scan map background. If MTT is entered from the unexpanded map

mode the displayed map background will freeze. The track diamond will appear over the target and an aircraft bug symbol will appear which indicates the ownship position on the frozen map display. Leading the Bug is a “+” symbol which indicates the predicted location of the ownship 30 seconds into the future based upon current speed and heading information available to the radar. At a range of 5 nm target data is displayed, as for any other track mode. Speed and heading errors are proportional to distance to the target. At 2 nm the radar will be twice as accurate as it is at 5 nm. A typical MTT frozen display is shown in Figure 7-35.

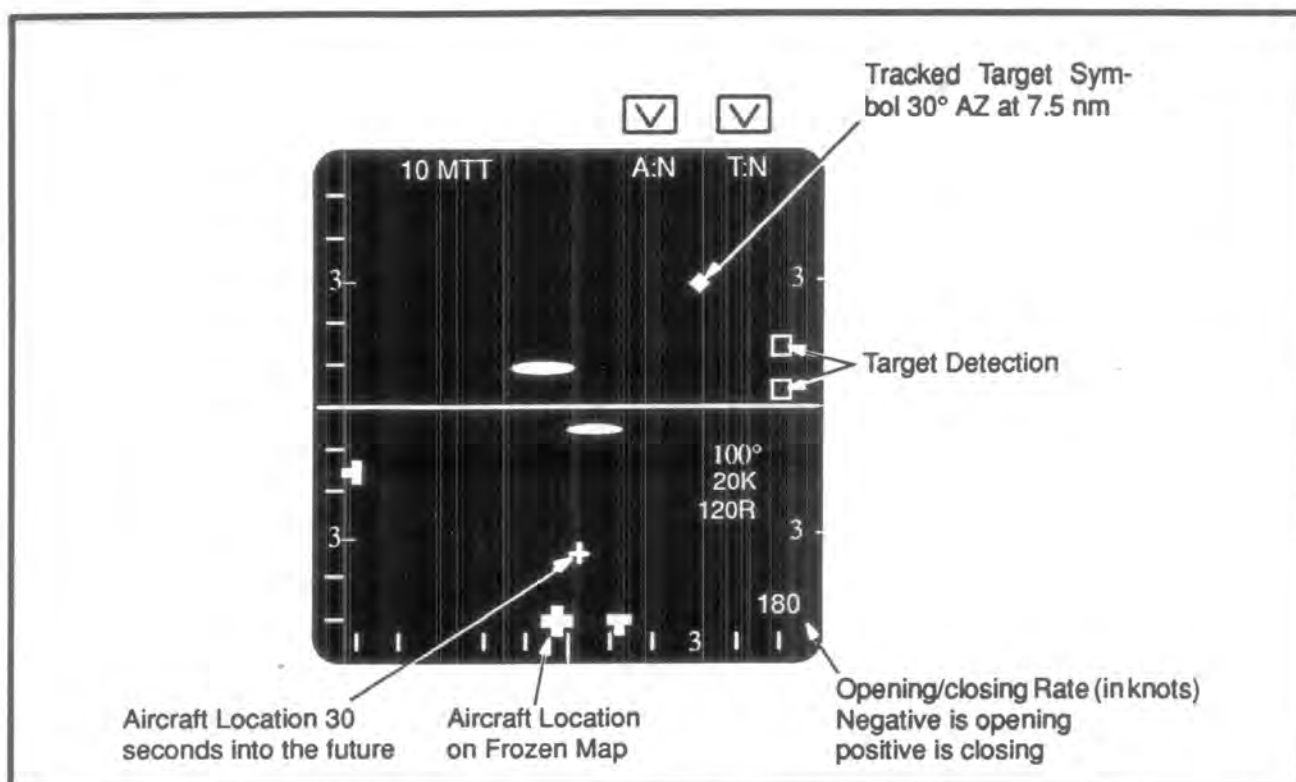


Figure 7-35 Typical MTT Frozen Map Display

7.248 The display can be unfrozen by pressing DESIG, or by entering MTT from one of the Expanded SEA modes.

7.249 Normally the tracked target is displayed as a solid diamond symbol. If the target is momentarily lost by the radar due to terrain masking, scintillation (varying target reflective properties) or some other natural phenomenon the solid diamond will change to an open diamond symbol and the radar will automatically transition into an INS tracking mode. Transition back to full track is also automatic and happens when the target becomes visible again.

7.250 If the tracked target goes into a gimbal limited situation the radar will not break track but will transition automatically into an INS tracking mode and the diamond will become an open diamond. When the ownship completes a turn for the intercept the radar will automatically resume active tracking when the target appears in the radar FOV. This feature provides the system with re-attack capability in which the target does not have to be manually re-acquired after an overfly.

7.251 On the right side of the DU all targets seen by the radar, which are close to the tracked target, are displayed. These targets are represented as open squares and they can have histories as selected on the RCP HIST switch. The exact centre of the display represents the range to the tracked target. The "3" symbol on the right side of the display represents 3,000 feet from the tracked target.

Approximately 3,000 feet of range coverage on either side of the tracked target is guaranteed although up to 6,000 feet may be provided depending upon the current radar pulsewidth.

7.252 One of the biggest problems in MTT mode is knowing when the radar is actually tracking a target or has transferred lock to the SEA clutter. Correct interpretation of the target display can give clues about radar performance. If the radar is tracking correctly there should be a square at the centre of the target range display (on the right side) representing the tracked target, and the target diamond displayed should be closed. Lack of the target square does not necessarily mean that the radar has broken lock but the track should be considered suspect. Similarly, if there is only one target on the display and it is offset from the centre, then this may be an indication that the radar has been pulled off and the track is no good.

7.253 Once locked on a target the radar will never return to the search mode automatically. Whether or not the radar is actively tracking must be determined from the display information, and manual break track (RT SCH) carried out if it is not.

7.254 MTT mode can be used to track a variety of maritime or ground targets against all kinds of background clutter. Typically any discrete target (i.e. one which is not distributed in nature) which can be seen on the DU map can be tracked.

NAVIGATION

INTRODUCTION

7.255 The navigation system provides guidance information and steering commands for navigating the aircraft to its selected destination. Navigation data is available from either inertial or navaid sources. This data can then be referenced to either NAS, Navaid, Offset Navaid or ADF information. Course selection can be direct, planned or fixed when using NAS reference, but only fixed when using navaid or offset navaid reference. Relative bearing only is available when using ADF. Table 7-22 lists the type of information and the source for all HUD, HSI, and ADI navigation indications.

7.256 Steering information is provided for all master mode selections, however it is limited to TAE steering and data window information when in A/G and A/A. When the NAV master mode is selected from any other mode the HUD symbology changes to show the navigation display, the STATUS page is shown on the alphanumeric DU and, if the RCP mode is AUTO, GM mode is automatically selected. The STATUS page is for information only, except that AFCS NAS steering can be toggled on or off.

NAS NAVIGATION

7.257 NAS navigation allows the pilot to navigate to the selected destination using bearing, distance displacement, and steering information from the INU. NAS navigation is selected by placing the REF switch on the NAV panel in the NAS position. The destination is selected from the points stored in the navigation data base and allows three different types of courses to be flown: planned, direct, and fixed.

Navigation Data Base

7.258 The navigation data base has the capability to store 50 nav points distributed as 20 Waypoints (including Initial/Offset point combinations and Invalid (X) points), 20 Navaid points and 10 Markpoints. Each waypoint is identified by a three character code identifying the type of waypoint and the storage location sequence number (00 thru 49). The data base defines a nav point as a lat/long, elevation, and desired time of arrival (DTOA). This data can be loaded and altered via the DTM or WPT key and viewed via the waypoint pages on the DU.

Waypoints

7.259 The first 20 navigation point storage locations are reserved for waypoints and are numbered 00 to 19. Each location may store a Waypoint (W point), Initial (I) point and its corresponding Offset (O) point, or an invalid (X) point. The waypoint number establishes the sequence in which the waypoints will be used as the destination when using the STP function or automatic destination sequencing. I/O point combinations are used to define a target and associated pop-up manoeuvre. In addition to the lat/long, elevation and DTOA stored in the data base, each O point has a bearing and distance from the I point, a pop up code, and a pop up direction. X points are invalid waypoints, meaning the NAS disregards that point. W points and I/O points can be removed by changing them to X points. If that point is subsequently redefined as a W or I/O point, the original data will be retained. X points are also loaded via the DTM at the end of a navigation route to fill any of the first 20 storage locations not needed.

Pop Codes

7.260 The pop up code identifies one of nine pop up definitions used to identify the pop up point in an attack manoeuvre. Each pop up definition includes the cross track distance (CTD), along track distance (ATD), and track miles (TM) from the pop up point to the offset point in nms. Pop up code 0 is always 0 nm CTD and 0 nm ATD. The remaining pop up codes (1 thru 8) can only be loaded into the NAS navigation data base via the DTM. These can be reviewed on the POP UP CODE page on the DU, accessed by selecting the POP CODE legend on page 2 of the MAIN INDEX. In the A/G master mode steering to the target will be direct, via the pop up point. Five seconds prior to the pop point, the FPM, BFL (if displayed) and aimpoint will flash until the pop point is reached. Steering will then be direct to the target. If the target is not designated re-attack steering direct to the target is provided while the aircraft remains inside the pop code TM + 2nm. Once outside TM + 2nm steering will be to the pop point circle radius to enable a further pop to be flown. Warning that TM + 2 is about to be exceeded is displayed by the FPM, BFL and aimpoint flashing when within 5 seconds of exceeding the distance. If the target is designated re-attack steering is always provided until the target is undesignated. Upon undesignating, for an I/O point target steering will be back to the I point, for a W point target, steering will be to the next waypoint.

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Table 7-22 Navigation Indications In Navigation Master Mode

			HUD				HSI					ADI			
REF Switch			Course Deviation Indicator and Course Pointer	ILS Pointers	Bearing Pointer	Track Angle Error	Bearing/Range Window	Course Pointer	Course Deviation Bar	Bearing Pointer	To/From Arrow	Distance Readout	Vertical Pointer	Horizontal Pointer	
NAS	CSE Switch		NAS Planned Magnetic Course to Current Destination and Displacement from that Course	Not Displayed	NAS Computed Magnetic Bearing to Current Destination	NAS Steering Command to Intercept Planned Course to Current Destination	NAS Computed Magnetic Bearing and Distance to Current Destination	NAS Planned Magnetic Course to Current Destination	NAS Computed Displacement from Planned Magnetic Course to Current Destination	NAS Computed Magnetic Bearing to Current Destination	NAS Computed To or From Current Destination	NAS Computed Distance to Current Destination	NAS Steering Command to Intercept Planned Course to Current Destination	Out of View	
	PLANNED					NAS Steering Command to Intercept Direct Course to Current Destination		NAS Computed Magnetic Course to Current Destination	Always Centered				NAS Steering Command to Intercept Direct Course to Current Destination		
	DIRECT					Not Displayed		NAS Steering Command to Intercept HSI Selected Magnetic Course to Current Destination	HSI Selected Magnetic Course to Current Destination				NAS Computed Displacement from HSI Selected Magnetic Course to Current Destination		NAS Steering Command to Intercept HSI Selected Magnetic Course to Current Destination
	FIXED					HSI Selected Magnetic Course to Current Destination and Displacement from that Course									
OFST NAVAID			HSI Selected Magnetic Course to Offset Navaid and Deviation from that Course		NAS Computed Magnetic Bearing to Offset Navaid	NAS Steering Command to Intercept HSI Selected Magnetic Course to Offset Navaid	NAS Computed Magnetic Bearing and Distance from Offset Navaid	HSI Selected Magnetic Course to to Offset Navaid	NAS Computed Deviation from HSI Selected Magnetic Course to Offset Navaid	NAS Computed Magnetic Bearing to Offset Navaid	NAS Computed To or From Offset Navaid	NAS Computed Destination to Offset Navaid	NAS Steering Command to Intercept HSI Selected Magnetic Course to Offset Navaid		
NAV AID	Navaid Received		HSI Selected Magnetic Course to TACAN Station and Deviation from that Course		TACAN Derived Magnetic Bearing to TACAN Sta.	NAS Steering Command to Intercept HSI Selected Course to TACAN Station	TACAN Derived Magnetic Bearing and Distance from TACAN Station	HSI Selected Magnetic Course to to TACAN Station	TACAN Derived Deviation from HSI Selected Magnetic Course to TACAN Station	TACAN Derived Magnetic Bearing to TACAN Station	TACAN Derived To or From TACAN Station	TACAN Derived Distance to TACAN Station	NAS Derived Steering Command to Intercept HSI Selected Course to TACAN Station		
	TACAN Station	DME Hold													NAS Derived Steering Command to Intercept HSI Selected Course to TACAN Station
		OFF													NAS Derived Steering Command to Intercept HSI Selected Course to TACAN Station
		HOLD			HSI Selected Magnetic Course to VOR Station and Deviation from that Course	VOR Derived Magnetic Bearing to VOR Station	NAS Steering Command to Intercept HSI Selected Course to VOR Station	VOR Derived Magnetic Bearing and Distance from VOR Station	HSI Selected Magnetic Course to to VOR Station	VOR Derived Deviation from HSI Selected Magnetic Course to VOR Station	VOR Derived Magnetic Bearing to VOR Station	VOR Derived To or From VOR Station	Covered		NAS Derived Steering Command to Intercept HSI Selected Course to VOR Station
VOR Station Only															
ILS Station		Not Displayed	ILS Derived Displacement from Localizer and Glideslope		Not Displayed	Not Displayed	TACAN Derived Distance to TACAN Station	HSI Selected Magnetic Course	ILS Derived Deviation from Localizer	Not Used	Out of View	TACAN Derived Distance to TACAN Station	ILS Derived Displacement from Localizer		ILS Derived Displacement from Glideslope

Navaid Points

7.261 The second 20 nav point storage locations in the navigation data base are reserved for nav aids and are numbered N20 to N39. The information is used to provide information on a nav aid facility, NAS steering to the Navaid position as stored in the data base, destination symbol positioning when in nav aid reference, and for position updating. Navaid point data can only be loaded via the DTM. Desired time of arrival is the only parameter that can be altered, and is carried out via the WPT key. N point data (except for declination) can be viewed via the nav aid pages on the DU or via the WPT key on the UFC.

7.262 Each nav aid point has the following information stored in the navigation data base:

- a. Location Name.
- b. Location Abbreviation.
- c. Latitude and Longitude.
- d. Elevation.
- e. Desired Time Of Arrival.
- f. Facilities and their channels/frequencies.
- g. Declination.

Mark Points

7.263 The last 10 nav point storage locations are reserved for markpoints and are numbered M40 thru M49. Markpoints are locations of significance marked during the flight. There are four methods of carrying out a mark: overfly, HUD, radar, and designated target. HUD and radar marks are valid only when in the NAV Master Mode; designated target only in A/G; and overfly in both NAV and A/G. The first mark accepted is stored as M40, the second as M41 and so on. Should more than 10 markpoints be stored during one flight, the 11th markpoint overwrites the oldest mark (M40), the 12th overwrites M41, and so on. Markpoint numbers are suffixed with a one- or two-character code indicating the method of marking. These are; O (overfly), H (HUD), R (radar), or DT (designated target). When the DTM is unloaded, any markpoints are transferred to the DTM. Markpoint data remains in the navigation data base until the INU switch is next selected to NAV. The position displayed on marking a point is derived from the NAS using INU position. Altitude derivation depends on the type of mark procedure. Each markpoint is stored with the following information:

- a. Marking Method Code
- b. Time of Marking
- c. Latitude and Longitude
- d. Elevation
- e. Desired Time Of Arrival

7.264 Elevation and desired time of arrival are the only alterable parameters and is accomplished via the WPT key. Markpoint data can be viewed via the markpoint pages on the DU or via the WPT key on the UFC.

7.265 Initiating a mark procedure while in a Master Mode that does not allow that mark procedure (i.e. any mark procedure in A/A or a radar or HUD mark in A/G) results in the message INVALID NAS MODE displayed in the markpoint scratchpad. This can be corrected by removing the scratchpad (ENT), then selecting the correct Master Mode and recommencing the mark procedure.

Overfly Mark

7.266 The overfly mark procedure enables a low level mark to be carried out when directly overhead a point of interest. It can be accomplished in either the NAV or A/G Master Modes. The procedure is initiated by pressing the MRK key on the UFC which displays the HUD mark scratchpad, flying directly over the point to be marked, and then selecting the overfly (OFLY) position of the radar/fix switch. At this point the lat/long, elevation, and time are displayed in the HUD scratchpad and can be accepted or rejected. Radar altimeter height is used (if available) to determine markpoint elevation regardless of whether the RAD ALT switch is in RAD ALT or WPNS. If the radar altimeter height is invalid, the stored destination elevation is used.

HUD Mark

7.267 The HUD mark can be used to mark a point of interest without overflying that point. The Master Mode must be selected to NAV prior to initiating the procedure. After pressing the MRK key on the UFC, the displayed mark symbol (triangle) at the flight path marker can be slewed to overlay the point to be marked. Designating will display the lat/long, elevation and time on the HUD scratchpad. The mark symbol can be slewed post designation to refine the mark point. The mark can then be accepted or rejected. Elevation is derived using radar slant range, radar altimeter, or destination elevation, in that order depending on the availability of the source. To obtain an accurate elevation the radar must be manually selected to AGR. If the mark position is designated with the radar not in AGR, selecting AGR then redesignating will update the elevation.

Radar Mark

7.268 The radar mark allows a radar identifiable point to be marked. A radar mark can only be performed in the NAV Master Mode with the radar in the Ground Map, Beacon, Sea 1, or Sea 2 mode. This includes expanded and DBS where applicable. The procedure is initiated by pressing the MRK key on the UFC followed by the RDR key. The radar cursors can then be slewed to the point of interest and that point designated. At this stage the latitude and longitude of the marked point, and time are displayed in the HUD scratchpad. The radar cursor may still be slewed to refine the mark if required. The markpoint information in the HUD scratchpad is continuously updated to reflect any movement in the radar cursor. The mark can then be accepted or rejected. During a radar mark procedure, the mark symbol on the HUD is slaved to the corresponding location of the radar cursor, thus overlaying the markpoint if assumed height above ground is accurate. Markpoint elevation is determined using radar altitude, if the RADALT switch is selected to WPNS, or stored destination altitude if the RADALT is not selected to WPNS. The message INVALID RADAR MODE will be displayed if the radar is not in an allowed mode.

Designated Target Marking

7.269 The designated target mark enables the position of a designated target to be marked and can only be performed in the A/G Master Mode. Pressing the MRK key after designating a target (either by the pickle, trigger or desig switch, dependent on A/G program) will display the latitude, longitude, elevation, and time in the HUD scratchpad. The mark can then be accepted or rejected as required.

Reviewing And Altering Nav Data

7.270 The primary means of entering data into the navigation data base is via the Data Transfer Module (DTM). If a DTM is not used, the waypoint locations 00 thru 19 are the only locations that can be manually entered. Navaid locations (N20-N39) from the previous flight will remain. The navigation data base can be reviewed on the DU, and reviewed or altered on the HUD via the WPT key. Review on the DU is accomplished via five index pages: two for waypoints, two for nav aids, and one for markpoints. These pages are accessed via the MAIN INDEX 1/2 page. Each index page allows selection of one

of ten nav point data pages for display on the DU. In addition, the WAYPT INDEX pages provide selection of the ROUTE CHECK pages. These pages display the bearing and distance between valid waypoints in the route sequence and the bearing and distance between each.

7.271 When using the scratchpad for navigation data base review, the WPT key provides access to the nav point information one nav point at a time. To alter the navigation data base, the information within each nav point location can be edited via the WPT key or information can be copied from one nav point location to another and then altered via the WPT key.

- a. *Copying Nav Point Data.* Data can be copied from any of the nav point locations into a waypoint location (locations 00 through 19). To accomplish this DTA 7 ENT will display the COPY prompt. Enter the nav point location number to be copied (00 thru 49) in the DEB, press the right arrow key to move the DEB to the next location, and then enter the waypoint location number (00 thru 19) to be copied to, followed by the ENT key. If either of the entry fields is blank when the ENT key is pressed, the scratchpad display is removed and no copy operation is performed.

CAUTION

If sequential locations within the waypoint locations (00 thru 19) have the same geographic locations, anomalies will occur in the presentation of navigation information.

- b. *Reviewing and Altering Nav Point Parameters.* To alter the parameters of a nav point, press the WPT key to obtain the waypoint number prompt. Enter the storage location sequence number (00 thru 49) of the nav point to be altered. Press the ENT key. The current information relating to the entered nav point is displayed. The Data Entry Box (DEB) is initially displayed around the most likely parameter to be altered. If this parameter requires altering, press the appropriate numeric keys to enter the new value. Once the entry is made, move the DEB to the next parameter to alter via the right (R) or left (L) arrow keys. The alterable parameters are either numeric entries or toggle entries. Table 7-23 shows the different states of all toggle entries.

Table 7-23 Toggle Entry Parameters

PARAMETER	OPTIONS	EXPLANATION
Waypoint Type	W, I, X	Changing an I point to a W or X point removes associated O point data. A later change back to an I point returns the O point with the same data.
Hemisphere	N, S, E, W	
ELEV Legend	(blank), -	Toggling on the ELEV legend, toggles between positive (blank) and negative elevation.
DTOA Legend	DTOA Value,	Toggling on the DTOA legend, (blank) displays or blanks the DTOA numeric field. A blank DTOA field indicates no DTOA associated with this nav point. Either the I point or the O point of a nav point pair can have a DTOA, but not both. Entry of one automatically removes the other. Pop Direction L, R.

NOTE

Pressing the ENT key following I point data entry displays the O point data display. O point data may be entered as a bearing and range from the I point or as a latitude and longitude.

Destination Selection

7.272 The NAS provides for manual destination selection or automatic destination sequencing. Selection is made on the WAYPT INDEX page on the DU. Pressing the key adjacent to the WPT SEQ legend toggles the selection between AUTO and MAN.

a. *Manual Selection.* Two types of manual selection are available; STP destination and CHG destination.

1. *STP Destination.* The destination can be manually sequenced to the next valid waypoint in sequence (skipping any X points) by pressing the STP key on the UFC. Use of the STP key is valid only when the current destination is the navpoint range 00 to 19. If the current destination is 19, pressing the STP key steps the destination to 00.

2. *CHG Destination.* The destination can be changed to any valid nav point via the HUD or the DU. To change the destination on the HUD, press the CHG key on the UFC, enter the location number (00 thru 49), and press the ENT key. To change the destination on the DU select WAYPOINT on the MAIN INDEX 1/2 page, select CHANGE to display the CHANGE DEST page, enter the desired nav point number, and select ENT. Entry of an X point results in an error indication.

b. *Automatic Sequencing.* Automatic destination sequencing at a waypoint is performed only when the current destination is a W point, when crosstrack deviation is less than 1 nautical mile, and when along track deviation becomes less than 1 nautical mile. Autosequencing is inhibited during a position update procedure. Any autosequencing that might have taken place during the update procedure, will take place upon completion or abortion of the update procedure. Autosequencing is also inhibited if the reference is moved from NAS. The destination at the time the reference is changed will again be the destination if NAS reference is reselected.

7.273 Destination sequencing is also accomplished when an I point is designated when in an A/G PLTS program. At this point the destination changes from the I point to the O point.

Course Selection

7.274 NAS navigation allows three different types of courses to be flown: planned, direct, and fixed. The CSE switch on the NAV panel allows the pilot to select the type of course best suited to the operational requirement. The CSE switch is only active when the REF switch is in the NAS position.

a. *Planned Course.* A planned course is the rhumb line between the previous destination and the current destination in the route structure. A planned course can be used with any nav point in the 00 to 19 range of the navigation data base. If a nav point in the 20 to 49 range is selected as the destination and the CSE switch on the NAV panel is in the PLANNED position, steering will be a direct course since no planned course exists for these nav points.

- b. *Direct Course.* A direct course is the rhumb line between the present position and the current destination. A direct course can be used with any nav point in the navigation data base.
- c. *Fixed Course.* A fixed course is the rhumb line to the current destination as selected by the HSI course set knob. A fixed course can be used with any nav point in the navigation data base.

Warning of Approaching a Destination

7.275 Within the distance/altitude criteria given in Figure 7-6 the destination symbol(s) will be displayed in the HUD. For a W, N and M point only the one symbol is displayed. For a I/O combination both symbols are displayed. When the calculated ETA to a destination reaches 20 seconds to go, the displayed ETA in Data Window R3 flashes for 5 seconds.

Steering Information Beyond The Destination

7.276 When having flown past the destination (i.e. sequencing did not take place) with planned or fixed course selected, the steering information continues on the outbound course. At one nautical mile beyond the destination, the flight path marker on the HUD flashes to draw attention to the divergent condition. When flying past the destination with a direct course selected, the steering information remains referenced to the direct course inbound to the destination.

Desired Time Of Arrival

7.277 The desired time of arrival (DTOA) can be entered for any of the 50 nav points in the navigation data base. When the REF switch is in the NAS position, and NAV or A/G Master Mode is selected, the airspeed necessary to make the desired time of arrival is displayed as commanded airspeed on the HUD. If more than one DTOA has been entered in the flight plan, the active one is the next DTOA in the waypoint sequence. If an O point is given a DTOA, the flight plan associated I point DTOA is automatically deleted, if one existed. Any DTOA must be specified in the same time zone as the inserted time of day. The maximum airspeed that can be commanded is 620 knots. When the commanded airspeed is greater than 540 knots and the current airspeed is not within 40 knots of the commanded airspeed, the commanded airspeed readout on the HUD flashes to alert the pilot to check the DTOA and route structure. The NAS uses the rhumb line distance between present position and destination to calculate commanded airspeed. When the active DTOA is for a waypoint beyond the destination, the NAS takes into account all leg distances between the current destination and the DTOA waypoint. When the active DTOA is for an O point with a POP, the NAS takes into account the track mile distance between

POP and O point when in the A/G Master Mode only. In calculating commanded airspeed, the NAS takes no account of the following:

- a. Turning radius at waypoints.
- b. Aircraft orientation with respect to the rhumb line between present position and destination.
- c. Vertical manoeuvres or waypoint vertical displacement.
- d. Weapon time of flight.

NAVAID NAVIGATION

7.278 With the NAV panel REF switch in NAVAID, steering is referenced to information being received from the tuned Navaid. The currently tuned navaid is always the steer-to-destination. In Navaid reference the only course available is Fixed. This is automatically selected regardless of the CSE switch position. Table 7-22 lists the type of information and the source for all HUD, HSI, and ADI navigation indications. A desired time of arrival cannot be inserted when using Navaid reference. To meet a desired time at the Navaid airspeed can be adjusted to make good ETA shown in Data Window R3. Destination symbol display and warning of approach to the destination (Navaid) is the same as for NAS reference. There is no warning that the aircraft is beyond the destination apart from interpretation of the displays. The destination symbol and track angle error steering are shown only for those navaids in the Navaid Data Base ie. N Points. Data window displays are described at Table 7-3.

OFFSET NAVAID NAVIGATION

7.279 Offset Navaid reference is selected when the NAV panel REF switch is in the OFST NAVAID position. The NAS takes the position of the tuned navaid, and biases this position by a pilot specified bearing, distance and elevation. The biased position becomes the steer-to-destination and all displays are referenced to this point. Table 7-22 indicates the information and its source for all HUD, HSI, and ADI navigation indications. Offset navaid navigation is possible only when valid bearing and distance from the tuned navaid is being received. If information is not valid, navigation indications are not displayed. Offset parameters are entered via the HUD scratchpad, DTA 6 sub menu. The offset parameters are entered using the standard procedures for HUD scratchpad data entry. A desired time of arrival cannot be inserted in Offset Navaid reference, but ETA at the biased "navaid" is available in Data Window R3. There is no warning that the aircraft is beyond the destination apart from interpretation of the displays. Data window displays are described at Table 7-3. The DU STATUS page will show the inserted offset bearing and distance.

HUD APPROACH MODE

7.280 The HUD approach mode is automatically displayed whenever the landing gear is selected down and the Master Mode switch is in the NAV position. Approach mode HUD symbology places emphasis on those symbols required on approach to land. The following changes occur in Approach mode:

- The Fuselage Reference Line replaces the Armament Datum Line and is placed 1 degree above the ADL.
- The Angle of Attack bucket is added to the left of the FPM.
- The VSI scale replaces the acceleration scale on the right side of the HUD. Current acceleration is shown digitally against the left side AOA carat.
- The -3 degree pitch markers are added to the pitch scale. These are displayed whenever the IAS is less than 250 knots, independent of gear selection.

STEERING AND GUIDANCE INFORMATION

7.281 All navigation displays are shown in the HUD (symbols and data windows) and are repeated on the ADI and HSI. Limited information is also provided on the DU STATUS page. A steering command is computed by the NAS to fly the aircraft onto the selected course. If the aircraft is off course, the deviation will be represented on the HSI presentations and the TAE carat and ADI vertical pointer will shown heading corrections to regain the appropriate track. All TAE steering commands provided by the NAS are based on a turn radius using an angle of bank of 27.5 degrees at the current TAS. The NAS will always attempt to provide a 90 degree intercept via the shortest route to the required track. When following the steering commands, the 90 degree intercept will only be reached if the aircraft is outside a distance of twice the turn radius from the track. Inside twice the turn radius, the commands will steer towards the 90 degree intercept only until a reversal (at 27.5 degrees angle of bank) will roll the aircraft out on track. With the NAS providing a 90 degree intercept, the TAE steering may provide an intercept past the steer-to-destination. Several examples of NAS-computed routes to a newly selected course are shown in Figure 7-36 to Figure 7-38.

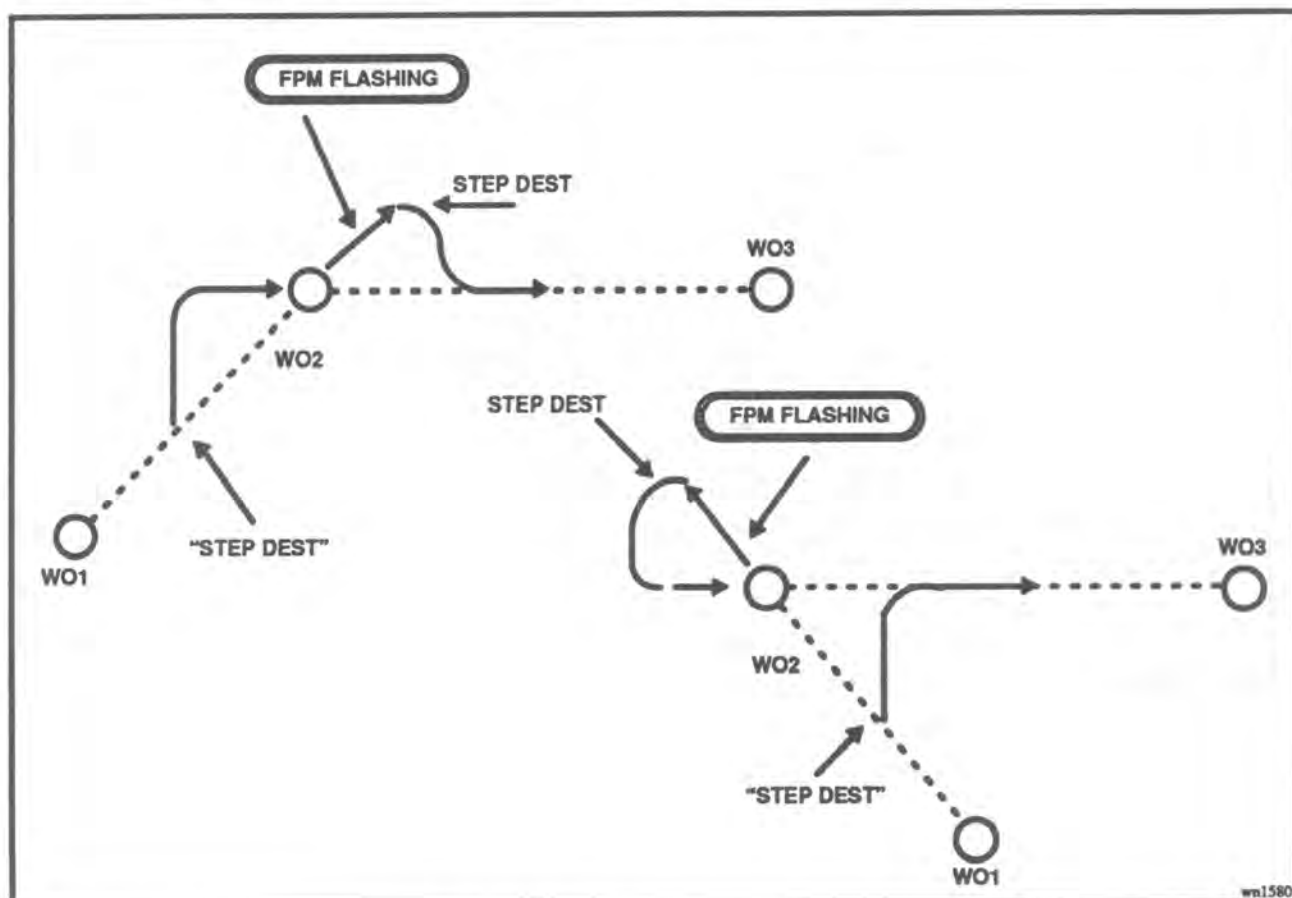


Figure 7-36 NAS Steering Examples – Planned Course

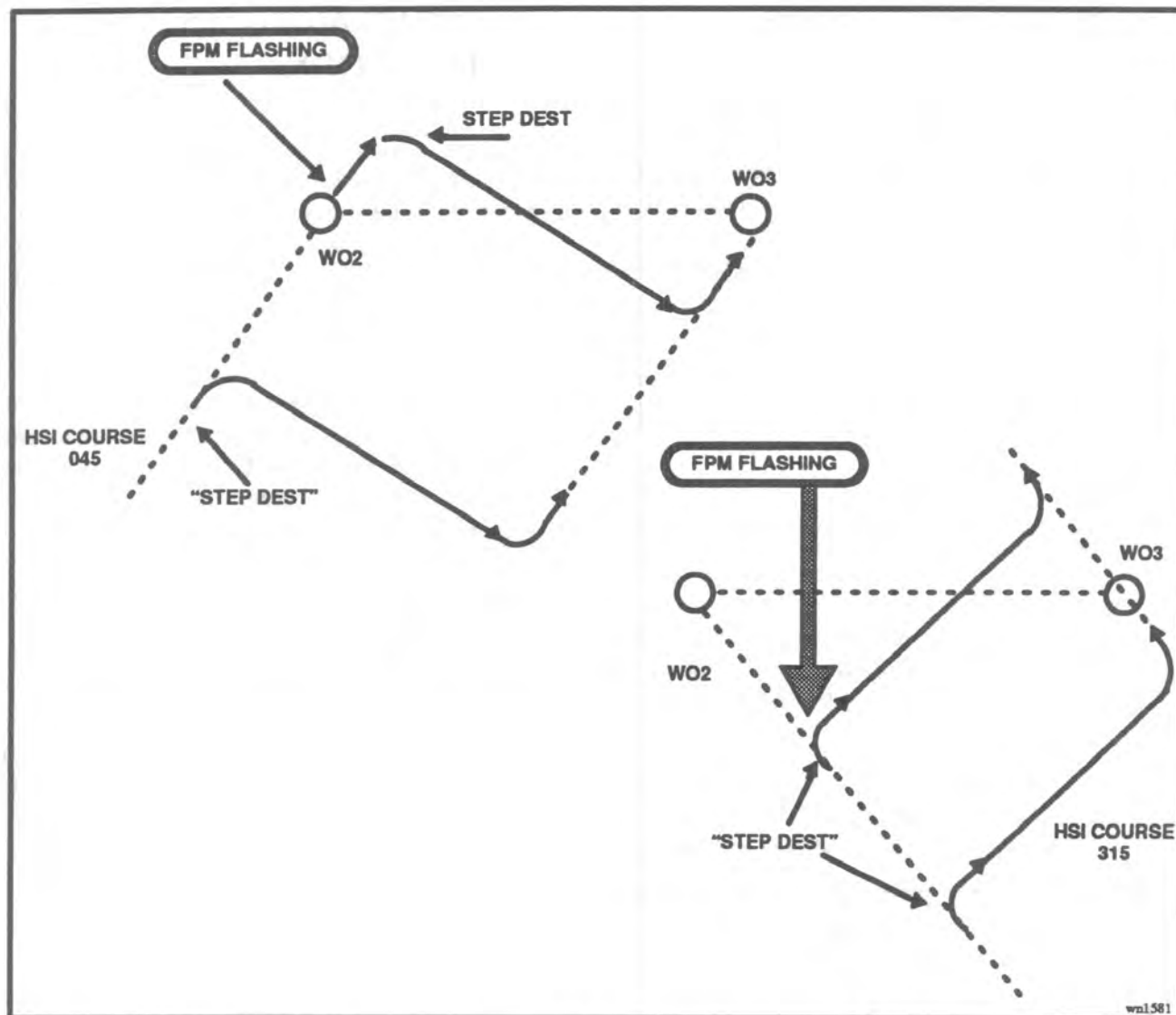


Figure 7-37 NAS Steering Examples – Fixed Course

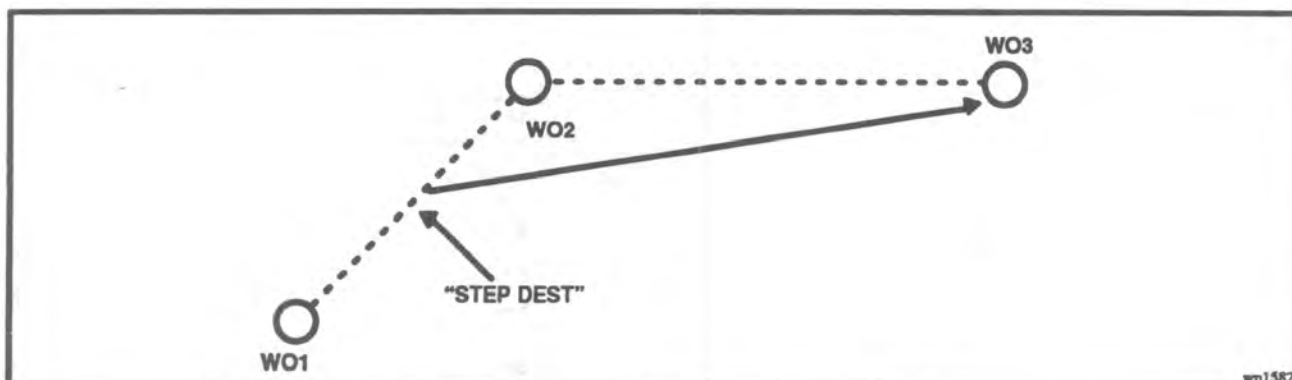


Figure 7-38 NAS Steering Example – Direct Course

CHAPTER 8

WEAPONS SYSTEMS

	PAGE		PAGE
ARMAMENT EQUIPMENT	8-1	Time To In Range (Guns and Rockets)	8-9
GENERAL	8-1	Pull Up Anticipation Cue	8-9
ARMAMENT CONTROLS	8-1	Break Cross	8-9
ARMAMENT PANEL	8-1	Time Of Flight "LO" Warning	8-9
Manual Weapons Switch	8-2	<i>Destination Symbol</i>	8-9
AGM 65	8-2	Sensor In Use	8-10
AUTO	8-2	Release Enable	8-10
GUNS	8-2	Master Arm Live	8-11
ROCKET	8-2	AGM 65 Seeker Reference Circle	8-11
BOMBS	8-2	Target Designate Box	8-11
AIM 9	8-2	LCOS Aiming Reticle	8-11
Arm Switch	8-2	CCIL Aiming Reticle	8-11
AIM 9 Coolant Switch	8-2	CCIL Bullet Trajectory Flight Line	8-11
Guns Switch	8-2	A/A Guns Range	8-11
Emergency Jettison Select Switch	8-2	Closure Rate	8-12
Station Select Indicators	8-3	AIM-9L Reference Circle	8-12
AFT ARMAMENT PANEL	8-4	Target Range Marker	8-12
THROTTLE ARMAMENT SWITCHES	8-4	Target Aspect Caret	8-12
Master Mode Switch	8-4	AIM-9L Line Of Sight	8-12
Program Change Switch	8-4	AIM-9L Launch Envelope Range Scale	8-12
Slew Control	8-4	Intercept Steering Pointer	8-13
Undesignate Switch	8-5	Steering Caret	8-13
Missile Step Switch	8-5	Steering Bar	8-13
Uncage Switch	8-5	Sleuable ACM Scan Pattern	8-13
Antenna Elevation Control	8-5	Targeting Sensor Selection	8-13
Chaff/Flare Switch	8-5	Data Windows in A/G Master Mode	8-14
CONTROL STICK	8-5	Data Windows In A/A Master Mode	8-14
ARMAMENT SWITCHES	8-5	Data Window Parameter Definitions	8-14
Bomb Release Button	8-5	DU OPERATIONS	8-18
Radar/Fix Switch	8-6	Weapon Inventory	8-18
Trigger Switch	8-6	<i>Clean a Station</i>	8-18
Master Armament Switch	8-6	<i>Load a Station</i>	8-18
Emergency Stores Release Handle	8-6	<i>Duplicate a Station</i>	8-18
HUD	8-7	<i>Specify TDD</i>	8-18
HUD SYMBOLOGY	8-7	Program Selection	8-19
A/G Aiming Reticle	8-7	Program Changes	8-20
Fixed Range Aimpoint	8-7	<i>Weapon</i>	8-21
Bomb Fall Line (BFL)	8-7	<i>Delivery Mode</i>	8-21
Bullet and Rocket Trajectory		<i>Sequence</i>	8-21
Flight Line (BTFL/RTFL)	8-7	<i>Quantity</i>	8-21
MRTS Cursors	8-7	<i>Space</i>	8-21
MRTS Radar Lock-On	8-7	<i>Target Elevation</i>	8-21
Target Diamond	8-7	<i>Break Height</i>	8-21
Time To Release (CCIP Bombs)	8-8	<i>Fusing</i>	8-21
Time To Release		<i>Arming</i>	8-21
(DVTS, PLTS, MRTS Bombs)	8-8	<i>Armament Live</i>	8-21

CHAPTER 8 Cont.

WEAPONS SYSTEMS

	PAGE		PAGE
RADAR WARNING SYSTEM (RWS)	8-25	BIT Check	8-30
INTRODUCTION	8-25	Initialise RWS	8-30
DIGITAL DISPLAY UNIT	8-25	Select A Function	8-30
Controls	8-25	Spread Display	8-30
RWS CONTROL PANEL	8-25	Initiate an Ambiguity Scroll	8-30
Mode Switch	8-25	If the RWS Indicator	
Function Select	8-27	Displays HT in the Centre	8-30
Execute	8-27	If the RWS indicator	
Advance	8-27	Displays CP in the Centre	8-30
True/Rel Switch	8-27	If the POWER Lamp on the	
BRT Control	8-28	RWS Control Panel Lights	8-30
RWS PROCESSOR	8-28	COUNTER MEASURE	
POWER SUPPLY	8-28	DISPENSING SYSTEM	8-31
ANTENNAS AND		CONTROLLER	8-31
AMPLIFIER RECEIVERS	8-28	Salvo Flare On/Off Switch	8-31
SYMBOLGY	8-28	Mode Pushbuttons and Indicators	8-31
System Status	8-28	Load Remaining Indicators	8-32
Known Emitters	8-29	Programmer	8-32
Unknown Emitters	8-29	DISPENSER HOUSINGS AND MODULES ...	8-34
Emitter Symbol Blink Rate	8-29	SEQUENCER SWITCH	8-34
Emitter Symbol Priority	8-29	PIN FLAG SWITCH	8-34
Audio Tone	8-29	CHAFF/FLARE INITIATE SWITCH	8-34
Automatic Antijamming	8-29	NORMAL OPERATION	8-34
RWS BUILT IN TEST	8-30	Ground	8-34
NORMAL OPERATION	8-30	Inflight	8-34

CHAPTER 8 Cont. WEAPONS SYSTEMS

FIGURES

TABLE	PAGE	TABLE	PAGE
8-1	Armament Panel	8-1	
8-2	Aft Armament Panel	8-4	
8-3	Throttle Switches	8-5	
8-4	Control Stick Armament Switches	8-6	
8-5	Master Arm Switch	8-6	
8-6	Aimpoint Symbol	8-7	
8-7	Fixed Range Aimpoint	8-7	
8-8	MRTS Symbol Operation	8-8	
8-9	Time To Release Symbology For Bombs	8-8	
8-10	Time To In Range Symbology For Guns And Rockets	8-9	
8-11	A/G CCIP, DVTS, and PLTS Sensor Usage	8-10	
8-12	Maritime Toss Sensor Usage	8-10	
8-13	Release Enable Symbology	8-10	
8-14	Master Arm Live Indication	8-11	
8-15	CCIL Symbology	8-11	
8-16	A/A Guns Range To Target Symbology	8-11	
8-17	AIM-9L Missile Reference Circle Symbology	8-12	
8-18	AIM-9L Missile Line Of Sight Symbology	8-12	
8-19	AIM-9L Missile Launch Envelope Range Scale	8-13	
8-20	Sensor In Use Indications	8-14	
8-21	Sample Inventory Index Display	8-18	
8-22	Inventory Load Displays	8-19	
8-23	A/G INDEX Page	8-20	
8-24	A/G PROGRAM Page (Bombs)	8-22	
8-25	A/G PROGRAM Page (Missiles)	8-23	
8-26	A/G PROGRAM Page (Rockets)	8-23	
8-27	A/G PROGRAM Page (Guns)	8-24	
8-28	A/G PROGRAM Page (Flares)	8-24	
8-29	RWS Control Panel	8-25	
8-30	RWS Digital Display Indicator	8-28	
8-31	Successful RWS BIT Test Display	8-30	
8-32	CDS Controller	8-31	
8-33	Programmer	8-32	
8-34	Chaff/Flare Initiate Switch	8-35	

TABLES

TABLE	PAGE	TABLE	PAGE
8-1	Station Select Pushbutton Operation	8-3	
8-2	Definition of L1, L2, R1 and R2 in A/G Master Mode	8-15	
8-3	Definition of L1, L2, and R1 in A/A Master Mode	8-16	
8-4	Data Window Parameter Definitions	8-17	
8-5	RWS CRT Symbology	8-26	
8-6	Unknown Emitter Display Symbols	8-29	
8-7	Mode Pushbuttons and Indicators	8-32	
8-8	ALE-39 Programmable Options	8-33	

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CHAPTER 8

WEAPONS SYSTEMS

ARMAMENT EQUIPMENT

GENERAL

8.1 This section describes the armament equipment available to release external stores in a non-tactical environment. A complete description of the aircraft weapons system is contained in the Tactical Manual. This Flight Manual is incomplete without the Tactical Manual (NZAP 6213.005-1-1 & NZAP 6213.005-1-1(S)).

8.2 The aircraft is equipped with two internal Mk 12 20mm guns. A gun is installed in each wing and each gun has a 100-round internal ammunition load capacity. The recommended maximum (to reduce the occurrence of guns stoppages) is 75 rounds per gun.

8.3 A 24 degree total field of view HUD is used in place of a gunsight. All navigation, attitude and weapon aiming information is displayed on the HUD, superimposed against the outside world, thereby enabling the pilot to devote his attention out of the cockpit throughout the attack profile.

8.4 Weapon aiming and release cues are computed by the NAS for display on the HUD. Weapons release sequences are also managed by the NAS in accordance with pilot selected programmes. A manual aiming and release capability exists as backup.

8.5 The aircraft is capable of carrying a wide variety of ordnance, including precision guided munitions. All stores are carried externally on five racks. A four-hook ejector bomb rack is installed on the centreline (fuselage) station, and a two-hook ejector bomb rack is installed on each of the four wing stations. The centreline rack (AERO 7A series) can be used to carry stores requiring either 30 or 14 inch suspension. Wing racks (AERO 20 series) are provided with 14 inch suspension only.

ARMAMENT CONTROLS

8.6 The cockpit includes an armament panel, throttle and control stick armament switches, HUD, master armament switch, and emergency stores release handle. A separate armament panel is provided in the aft cockpit of the TA-4 providing a limited repeat of the forward panel functions. There is no HUD in the aft cockpit, however the forward HUD picture can be videoed to an aft DU.

ARMAMENT PANEL

8.7 The armament panel shown in Figure 8-1 is located below the instrument panel. Armament panel controls consist of the MANUAL WPNS switch, ARM switch, AIM 9 coolant switch, GUNS switch, EMER SEL switch and the station select indicators.



Figure 8-1 Armament Panel

AL 6(0)

Manual Weapons Switch

8.8 The MANUAL WPNS switch enables the pilot to deliver weapons manually in the event of a failure within the NAS. Six weapon delivery modes are available depending on the switch position. These are:

AGM 65

8.9 In the A/G mode with AGM 65 selected, all NAS programmes associated with the trigger are operable (AGM, rockets, guns, flares); programmes associated with the pickle button are not operable (bombs). Additionally, seeker gyro power is applied to all AGM 65 missiles. This position is not used in A/A.

AUTO

8.10 AUTO enables all NAS weapons programmes and is the position normally selected.

GUNS

8.11 GUNS enables the pilot to fire the guns using the trigger, providing the MASTER ARM is selected and the GUNS switch is READY.

ROCKET

8.12 In the A/G mode, ROCKET enables the pilot to fire rockets using the trigger, provided a loaded station is selected and ready and the MASTER ARM is selected.

BOMBS

8.13 In the A/G mode, BOMBS enables the pilot to release bombs using the bomb button, provided a loaded station is selected and ready and the MASTER ARM is selected.

AIM 9

8.14 AIM 9 is used in A/A only and enables the pilot to fire a missile if a loaded station is selected and ready and the MASTER ARM is selected.

Arm Switch

8.15 The ARM switch is a 3 position toggle switch labelled **HIGH**, **SAFE** and **LOW** which determines fusing and tail configuration for manually delivered bombs. It is active only when the MANUAL WPNS switch is in the **BOMB** position. **HIGH** selects SERET bombs to the high drag configuration with 10.0/INST fusing. Conical bombs will be released low drag with 10.0/INST. With **SAFE**

selected, all bombs will be released low drag with no fusing. **LOW** selects low drag configuration with 5.5/INST fusing.

AIM 9 Coolant Switch

8.16 The AIM 9 coolant switch is a 3 position toggle switch labelled **COOL**, **STBY** and **OFF**. The coolant switch powers the sidewinder control system and controls cooling of the missile IR detectors. In the **COOL** position the sidewinder system is ON and all missiles are cooled. With **STBY** selected, the sidewinder system is ON but missiles are only cooled when MASTER ARM is in ARM and A/A Missile mode is selected. In the **OFF** position, the sidewinder system is OFF.

Guns Switch

8.17 The GUNS switch is a two position toggle switch with positions identified as **SAFE** and **READY**. When the switch is in the **SAFE** position, the breechblock of each gun is in the withdrawn position and firing is inhibited. When selected to **READY**, the breechblocks are pushed forward, forcing a round into the breech, and firing circuits are completed ready for firing.

WARNING

*DO NOT CYCLE THE GUN CHARGER. Movement of the GUNS switch from **READY** to **SAFE** and back to **READY** can cause an explosion by ramming a new round against a jammed one. Cycling the landing gear with the GUNS switch in the **READY** position produces the same results. The MASTER arm switch must be used to interrupt the trigger circuit between runs.*

Emergency Jettison Select Switch

8.18 The emergency jettison select switch, identified EMER SEL, is a rotary switch labelled **WING**, **1**, **2**, **3**, **4**, **5**, and **ALL**. The switch provides selection of the external stores to be jettisoned when the emergency stores release handle (EMER BOMB T-handle) is pulled. Stores can be jettisoned sequentially if desired. The EMER SEL switch functions with either the main or emergency generator in operation. AIM 9/AGM-65 missiles and launchers cannot be jettisoned.

Station Select Indicators

8.19 Five station select indicators provide for selection of any station or combination of stations for firing or release (except for emergency release) of external stores when the MANUAL WPNS switch is in the **BOMBS** or **ROCKET** position. In all other positions, the pushbutton function of the station select indicator is inoperative. A

number below each indicator identifies the external stores station it controls.

8.20 The indicators are pushbutton, internally lighted type, consisting of an upper green **ON** lamp and a lower yellow **READY** lamp. The operation of the **ON** and **READY** lamps varies as a function of the position of the MANUAL WPNS switch. These operations are described in Table 8-1.

Table 8-1 Station Select Pushbutton Operation

MANUAL WPNS Switch Position	Station Select Pushbutton Function	On Light	READY Light
GUNS	None	No function	No function
BOMBS	Selects/deselects station for bomb release	Station has been selected	Station is selected and bomb is present
ROCKET	Selects/deselects station for rocket or flare firing	Station has been selected	Station is selected and rocket or flare is present
AUTO Bomb, Rocket, or Flare Program	None	Indicates station has been selected by the CIU	Station is selected and bomb, rocket or flare is present
AGM 65 Program	None	Indicates station has been selected by the CIU	AGM 65 missile is present and ready
Guns Program	None	No function	No Function
AGM 65 Rocket or Flare Program	None	Indicates station has been selected by the CIU	Station is selected and rocket or flare is present
AGM 65 Program	None	Indicates station has been selected by the CIU	AGM 65 missile is present and ready
Guns Program	None	No function	No function
AIM 9	Inoperative	Indicates which station has the priority missile	Indicates which station(s) have active missiles

AFT ARMAMENT PANEL

8.21 An aft armament panel shown in Figure 8-2 is located at the bottom edge of the aft cockpit instrument panel of the TA-4K. The aft panel contains station select indicators and an EMER SEL switch. The station select indicators simply repeat the lit indications shown on the forward cockpit pushbutton indicators.

8.22 The EMER SEL switch provides selective jettison of external stores in conjunction with the aft emergency stores (EMER BOMB) release T-handle. The switch is a 3 position toggle switch labelled **ALL**, **CTR**, and **WING**. In the **ALL** position, emergency jettison is selected for all stations. The **CTR** position selects station 3 for emergency jettison. A detent is provided at this position and the switch must be lifted out of the detent to be moved from **CTR**. In the **WING** position, stations 1, 2, 4, and 5 are selected for emergency jettison.

THROTTLE ARMAMENT SWITCHES

8.23 The throttle contains several switches which provide the pilot with a HOTAS capability particularly in the air to air environment. Some of these switches have dual functions depending on the master mode selected (air

to ground or air to air). Throttle switches are shown in Figure 8-3.

Master Mode Switch

8.24 The master mode switch is a 3 position toggle switch used to select one of three master modes. In the rear (A/G mode) position, program #1 is selected and displayed on the DU and the relevant symbology is presented in the HUD. The centre position is navigation. In the forward (A/A mode) position, air to air missile mode is selected and presented in the HUD, with the stadiametric range page shown on the DU.

Program Change Switch

8.25 The program change switch is a depressable button which sequentially cycles between the first 4 weapons programs in the A/G mode or 3 programs in the A/A mode. A/G programmes are preset by the pilot either using the MDGT or through the DU. A/A programmes are fixed as A/A Missile, CCIL Guns and LCOS Guns.

Slew Control

8.26 The slew control is a press-and-slew type switch enabling the pilot to slew various HUD and radar symbols, radar scan pattern, AGM-65 missile line-of-sight and acquisition gates depending on the system operating mode.

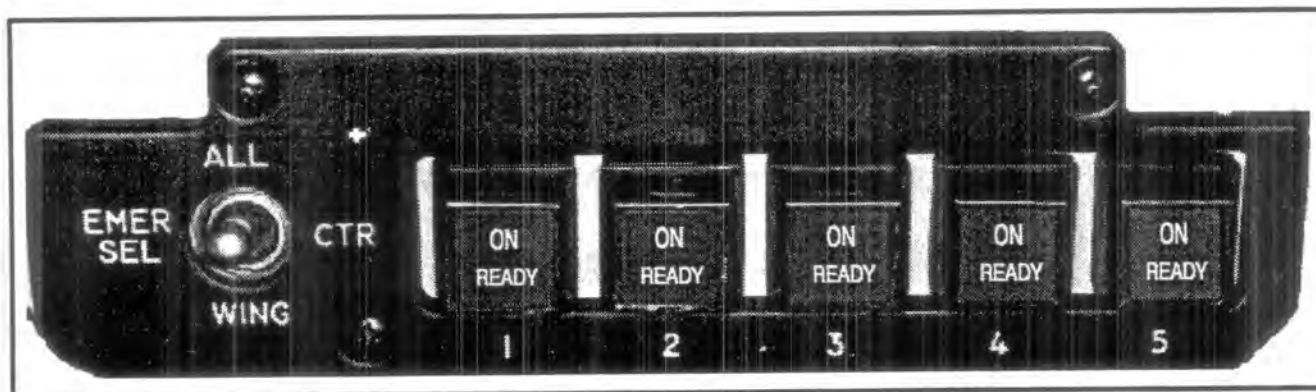


Figure 8-2 Aft Armament Panel

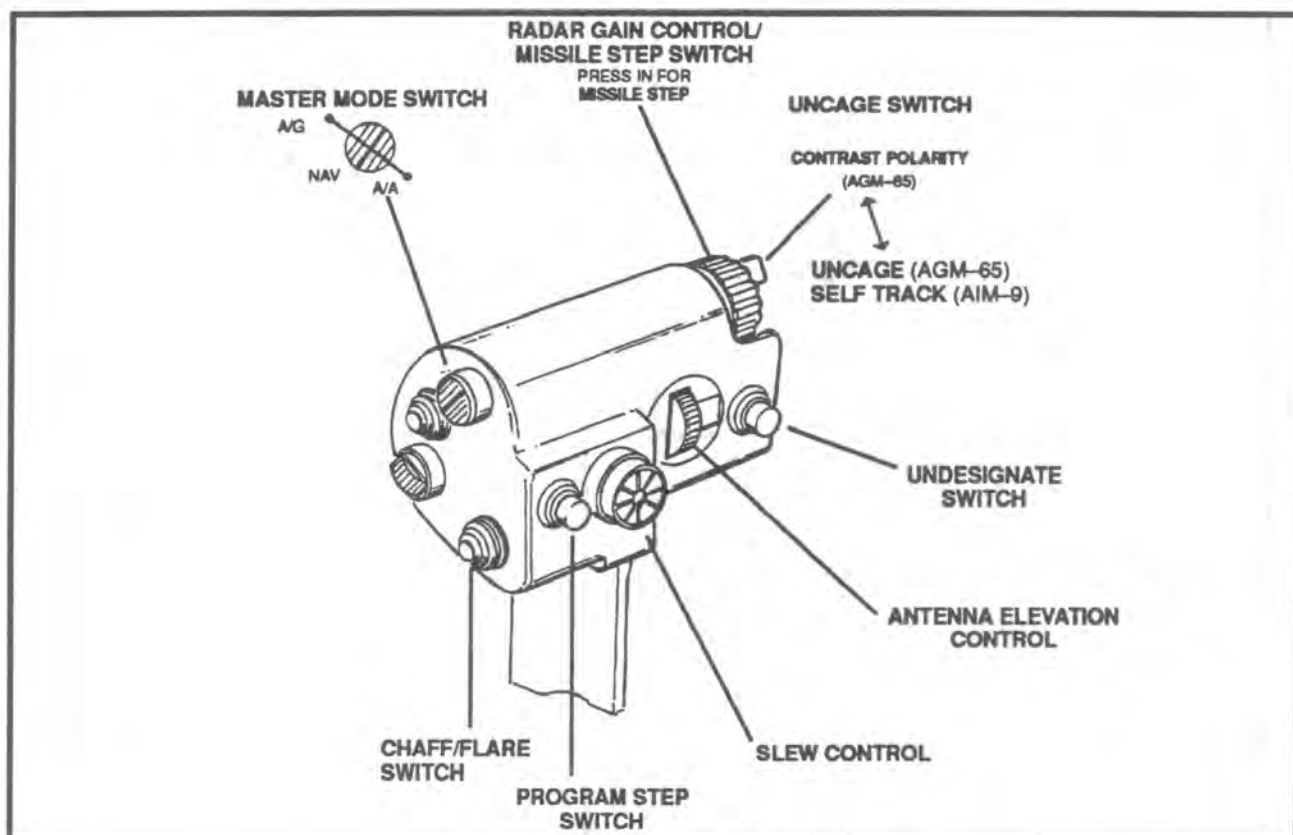


Figure 8-3 Throttle Switches

Undesignate Switch

8.27 The undesignate switch is a button used only in the A/G mode. When pressed, the switch undesignates the target, cancels re-attack steering, and re-initializes the selected weapons programme as if it were just selected.

Missile Step Switch

8.28 The rotatable Radar Gain switch is also the missile step switch. Inward pressure on this control deselects the currently controlled missile (AGM-65 or AIM-9L depending on master mode) and selects the next missile in priority sequence. In A/A gun modes, the radar gain switch functions as a stadiametric range control.

Uncage Switch

8.29 The uncage switch is a 2 way toggle switch which may be pressed up or down. In the A/G mode, pressing the uncage switch down uncages the AGM-65 missile. Pressing the switch up steps video contrast polarity of the uncaged missile through W/B, B/W and AUTO (W/B is the default setting). In the A/A mode, pressing the uncage switch down alternately cages and uncages the AIM-9L missile, respectively disabling and enabling missile self track.

Antenna Elevation Control

8.30 The antenna elevation control is a potentiometer type switch used to adjust the elevation of the centre of the radar antenna scan pattern.

Chaff/Flare Switch

8.31 The chaff/flare switch is a 4 position switch used to initiate the Countermeasures Dispensing System for release of chaff, flares and expendable jammers. This switch is active whenever the chaff/flare safety pin is withdrawn, the gear is UP and the CDS switch is selected to the ON position.

CONTROL STICK ARMAMENT SWITCHES

Bomb Release Button

8.32 The bomb release button, referred to as the pickle button, is located on the left side of the control stick grip as shown in Figure 8-4. When the MANUAL WPNS switch is in the AUTO position, pressing the pickle button designates the aimpoint as the target and enables release consent for the NAS selected weapon. The pickle button must be held down until weapon release occurs (at least 0.35 sec). Releasing the switch prematurely will inhibit weapon release. With the MANUAL WPNS switch selected to BOMBS, pressing the pickle button enables instant release of bombs from the selected station(s).

8.33 The bomb release button functions only in the A/G mode

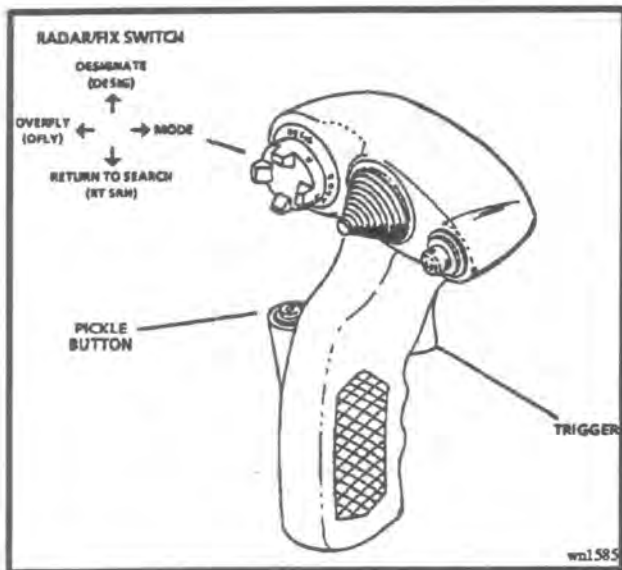


Figure 8-4 Control Stick Armament Switches

Radar/Fix Switch

8.34 The radar/fix switch is a 4 position toggle switch marked **DESIG**, **MODE**, **RT SRH** and **OFLY**. The function of these positions depends on the master mode selected. In A/G, pressing the switch toward **DESIG** designates the ground/sea coordinates of the target or I point based on either the LOS of the appropriate HUD symbol or the radar cursor. It is also used to initiate radar MTT acquisition and lock-on. In A/A, **DESIG** is used to designate an aircraft for radar tracking when the radar is in the Air Search mode, or to select radar to Boresight when in the ACM modes.

8.35 The **MODE** position is used to toggle radar modes.

8.36 The **RT SRH** position cycles the radar between expanded and unexpanded modes in A/G; and is used to break track or select radar scan patterns in A/A.

8.37 The **OFLY** position is used in A/G to designate the ground location directly beneath the aircraft as a markpoint during a markpoint procedure. It is not used in A/A.

Trigger Switch

8.38 The trigger is located on the front of the control stick grip and initiates firing of guns, rockets, flares or missiles depending on the position of the **MANUAL WPNS** switch and the A/G or A/A weapons programme selected.

Master Armament Switch

8.39 All armament circuits are controlled by the **MASTER ARM** switch (Figure 8-5) with the exception of gun charging, countermeasures dispensing and emergency jettison of external stores. The **MASTER ARM** switch is located on the left side of the instrument panel above the

vertical speed indicator, and must be in the **ARM** position to energize armament circuits.

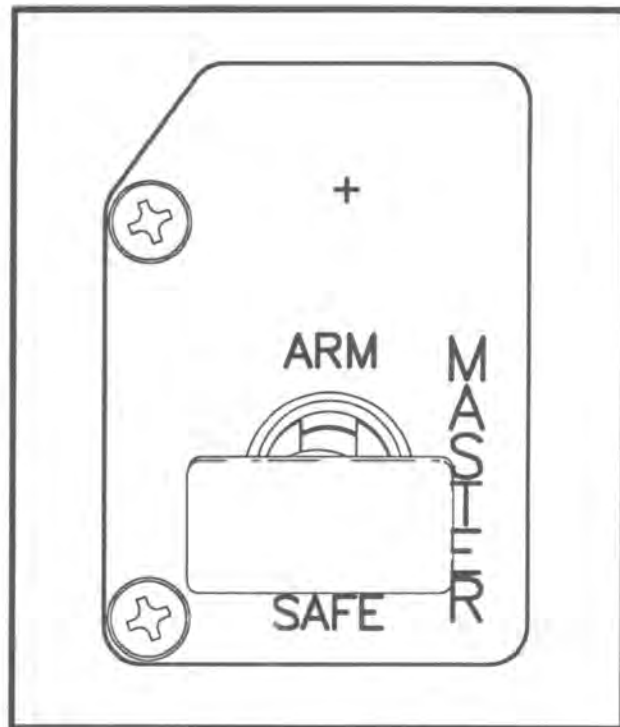


Figure 8-5 Master Arm Switch

WARNING

*The **DRAG CHUTE** switch is similar to the **MASTER ARM** switch. Due to the proximity of the switches and their operation by the pilot's left hand, it is possible to inadvertently operate the **DRAG CHUTE** switch, thereby deploying the drag chute inflight. This is particularly possible if looking outside for target acquisition whilst selecting the **MASTER ARM LIVE**.*

Emergency Stores Release Handle

8.40 An emergency stores release handle, identified **EMER BOMB**, is located on the lower left side of the instrument panel. Pulling the handle closes a switch in the emergency release circuit, bypassing the normal release controls. Power to the emergency circuit is supplied through the primary bus which is energized by either the main or emergency generator. Stores are released as selected on the **EMER SEL** switch, regardless of the position of the landing gear or **MASTER ARM** switch.

HUD

8.41 The HUD is located on the top centre portion of the forward cockpit instrument panel. A visual display, in symbol/numeral form, of weapon delivery and navigation data is presented on the HUD in the pilot's forward field of view. A more technical description of the HUD is contained at Chapter 7. HUD symbology for each of the Attack modes is described in the following paragraphs.

HUD SYMBOLOGY

A/G Aiming Reticle

8.42 Prior to target designation the aiming reticle is displayed as an eight milliradian circle with a one milliradian centre dot. The inner diameter of the circle is six milliradians.

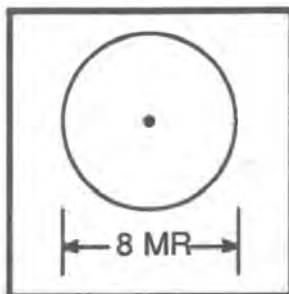


Figure 8-6 Aimpoint Symbol

8.43 In the case of ripple bomb programs, the aimpoint symbol indicates the centre of the bomb stick.

8.44 When the ground is beyond the maximum effective range of the selected weapon, the aiming reticle indicates the impact at the specified maximum range of the weapon and an "X" is superimposed over the symbol to alert the pilot that the aimpoint is not valid, i.e. it does not indicate the weapon impact LOS.

Fixed Range Aimpoint

8.45 When the beyond effective range aimpoint for rockets and guns is less than 3° below the horizon it is replaced by a fixed range aimpoint. The fixed range

aimpoint is a dot placed approximately 1.5° below the ADL for guns, and 4.5° below the ADL for rockets.

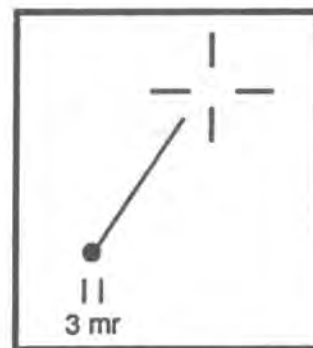


Figure 8-7 Fixed Range Aimpoint

Bomb Fall Line (BFL)

8.46 The Bomb Fall Line is displayed from the FPM to the aiming reticle to assist the pilot in positioning the aiming reticle over the target. The BFL is removed while the pickle button is depressed.

Bullet and Rocket Trajectory Flight Line (BTFL/RTFL)

8.47 When Guns or Rockets are selected either the BTFL or RTFL is drawn connecting the ADL and the aiming reticle.

MRTS Cursors

8.48 In NAV and MRTS A/G Programs when the Radar (SEA 1 or SEA 2) is not locked on to a target, the MRTS cursor is displayed at the surface co-ordinates of the radar cursors.



MRTS Radar Lock-On

8.49 When the radar is locked on to a target in the sea modes, the MRTS lock-on symbol replaces the MRTS Cursor.



Target Diamond

8.50 When a target is designated, the aiming reticle is replaced by an 8 mr ground stabilised target diamond, which remains until the target is undesignated.



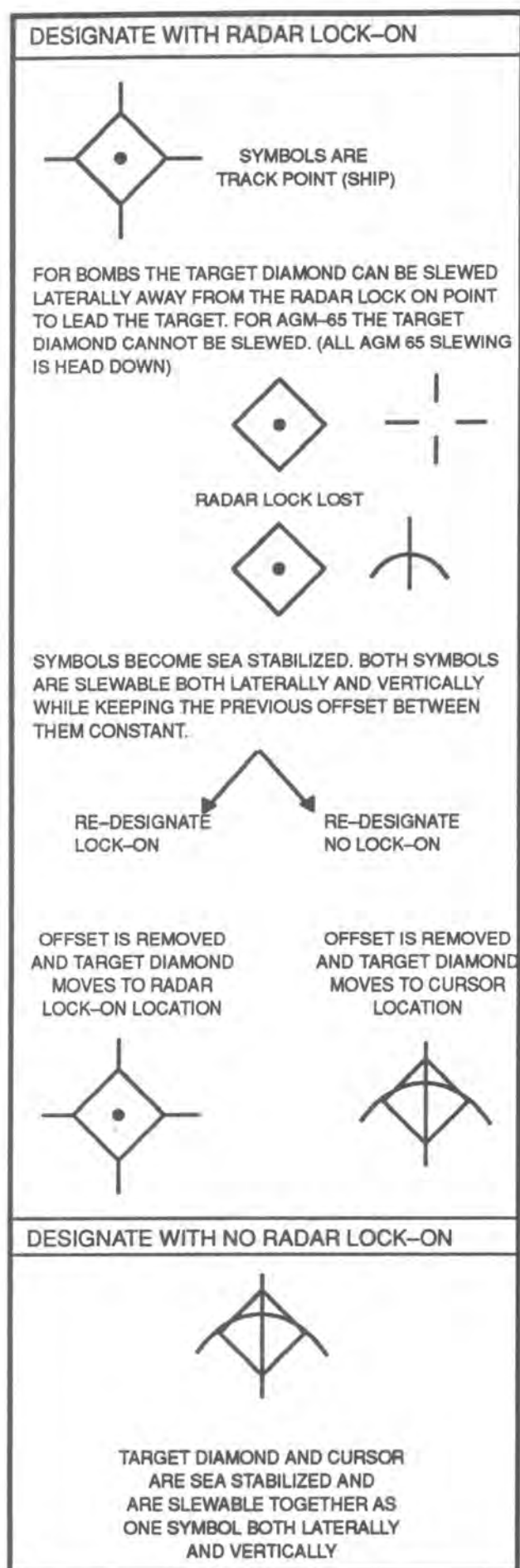


Figure 8-8 MRTS Symbol Operation

Time To Release (CCIP Bombs)

8.51 The time to release bar indicates the predicted delay between designation (pickle) and bomb release and is only displayed during a delayed release condition, where the aimpoint is at the CCIP aimpoint limit. The time to release bar is positioned along the bomb fall line at a distance from the aimpoint equal to 2.5mr for each second of delay and is limited to a maximum of 10 seconds (25mr)

8.52 As Time to Release decreases, the cue moves down the BFL until it touches the aiming reticle, where it is removed, indicating an immediate release condition exists.

8.53 If the pickle button is pressed during delayed release conditions, the time to release bar is transferred to the steering bar and referenced to the flight path marker (FPM). After pickle, the time to release bar moves down the steering bar toward the FPM. The rate of movement will be about one MR per second if the current flight path angle is maintained but be faster if a pull-up is performed. When time to release bar reaches the centre of the FPM, the time to release bar is removed and weapon release begins.

8.54 The travel distance from the top of the steer bar to the centre of the FPM represents 10 seconds. If time to release is greater than 10 seconds, the time to release bar is displayed at the top of its travel (the 10-second position).

Time To Release (DVTS, PLTS, MRTS Bombs)

8.55 Once "in range" the Time to Release bar is steady and moves down the steering bar toward the FPM. When time to release goes to zero, the bar is positioned at the elevation of the centre of the FPM. Following target designation, anticipation of being "In Range" is shown by the flashing of the Time to Release cue on the steering bar for twelve seconds. Once in range, the cue is steady.

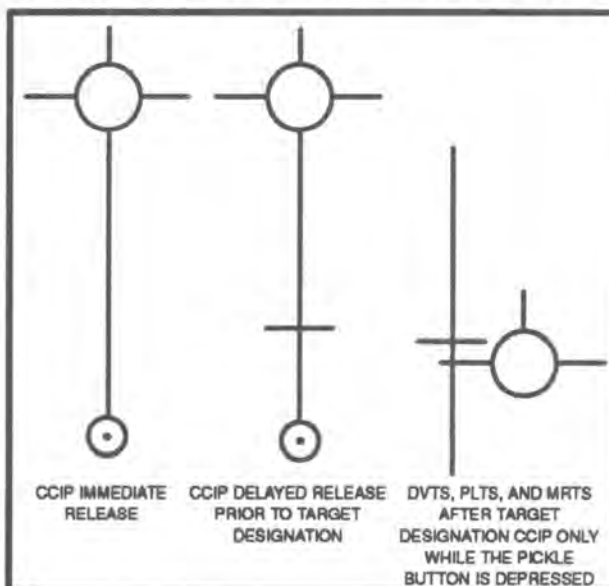


Figure 8-9 Time To Release Symbology For Bombs

Time To In Range (Guns and Rockets)

8.56 In Guns and Rockets, Time to In Range indicates the time to reach the maximum specified weapon range. The cue is positioned on the weapon line with respect to the aiming reticle, and indicates that the ground is beyond the maximum effective range of the weapon; an X is superimposed over the reticle and the symbol is placed at that range. The weapon will not impact at the ground at the point over which the symbol is positioned. The symbol is removed when an effective weapon range is reached and, when the fixed range aimpoint is displayed.

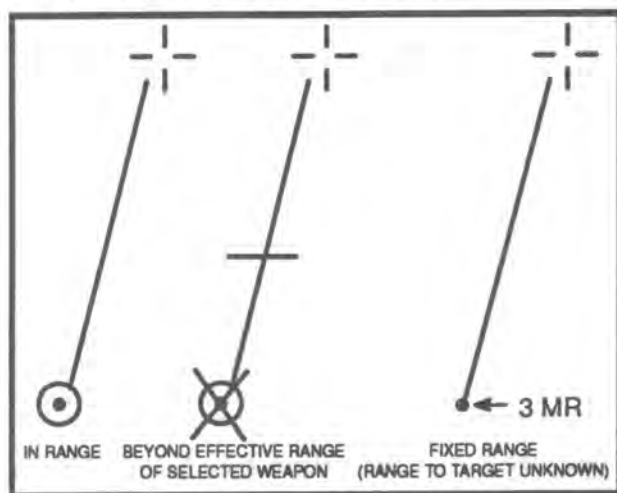
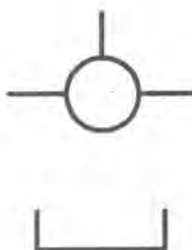


Figure 8-10 Time To In Range Symbolology For Guns And Rockets

Pull Up Anticipation Cue

8.57 A roll stabilized Pull Up Anticipation Cue (PUAC) is displayed relative to the FPM to indicate time to penetration of the specified break height (based on current flight conditions) associated with the selected A/G program. When the PUAC reaches the centre of the FPM it is replaced by the Break Cross.



Break Cross

8.58 A flashing Break Cross is displayed at the centre of the HUD FOV, when the NAS calculates a 4g pull at a rate of 1.5g per second is required to recover above the inserted break height. (A one second pilot reaction time is included). The cross is removed with the CLR key and is rearmed by the aircraft climbing above the break height.



Time Of Flight "LO" Warning

8.59 When the predicted time of flight of the bomb is within 2 secs of the specified fuse arming time, the caption "LO" is flashed at the centre of the HUD FOV. When the predicted time of flight of the bomb is less than the specified fuse arming time, the caption LO becomes steady.

NOTE

The pickle button should be released immediately and the attack discontinued should the steady LO caption be displayed.

8.60 This applies to all bombs including practice weapons which are assumed to have the same arming time as the weapons they represent.

Destination Symbol

8.61 The destination symbol indicates the ground location of the current destination, just as it does in the Nav master mode. When the destination is so far away that the symbol would appear on the horizon, the destination symbol is not displayed. The destination symbol is removed once the target is designated.

Sensor In Use

8.62 In A/G programs if the sensor being used to determine target co-ordinates is not the primary method, a code letter is displayed above the FPM or ADL. The order of priority for sensor use is; radar ranging, followed by radar altimeter, followed by baro-inertial altitude.

- a. *CCIP, DVTS, and PLTS.* When the source of target co-ordinate data is Radar air to ground ranging, no altitude sensor source symbology is displayed as this is the primary method of ranging. When the radar altimeter is the source of target co-ordinate data, an "R" is displayed above and to the left of the FPM. When baro-inertial altitude is the source of target co-ordinate data, an "I" is displayed above and to the right of the FPM.

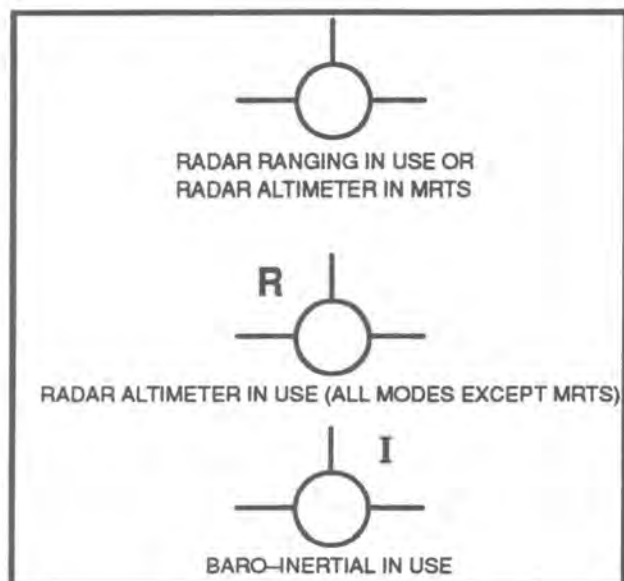


Figure 8-11 A/G CCIP, DVTS, and PLTS Sensor Usage

- b. *MRTS.* An indication of which sensors are currently being used to determine target position for a MRTS program is presented in the HUD. Radar lock-on status is indicated by the MRTS radar lock-on symbol when the radar is locked on and by the MRTS radar cursor symbol when the radar is not locked on. Since radar altitude is used in the primary sensor mode to determine height above the sea, no indication is made when the radar altimeter data is being employed. When radar altitude is not valid, an "I" appears adjacent to the FPM, which indicates that the MRTS mode is now using baro-inertial altitude.

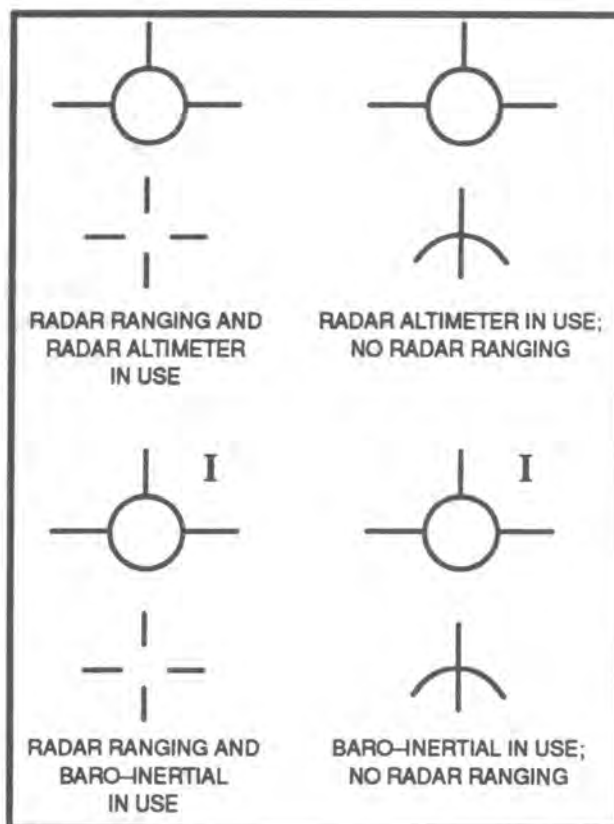


Figure 8-12 Maritime Toss Sensor Usage

Release Enable

8.63 When the bomb release (pickle) button is pressed, a "P" is displayed; or when the trigger is squeezed, a "T" is displayed for the duration of the switch activation, at the lower inboard edge of the G scale.

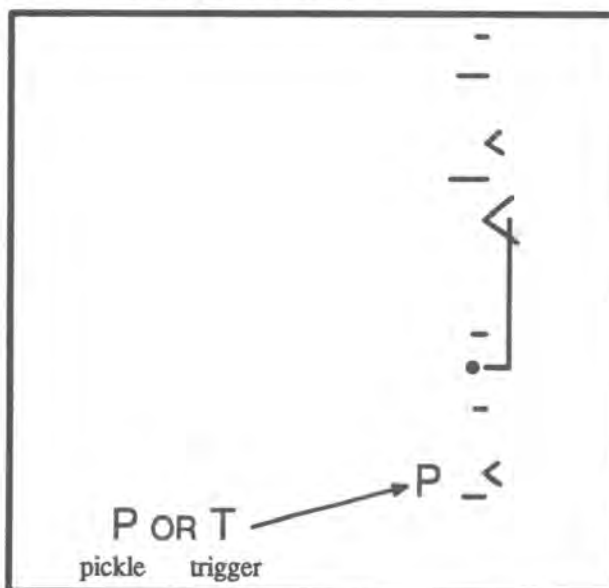


Figure 8-13 Release Enable Symbology

Master Arm Live

8.64 A "LIVE" indication is placed immediately inboard of, and equal with the bottom of the AOA scale whenever the Master Arm switch is in the "LIVE" position.

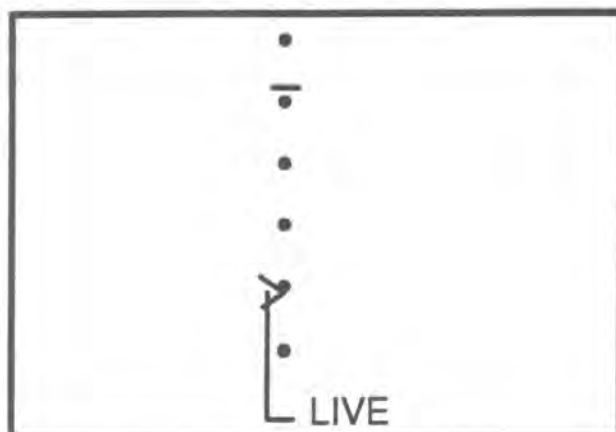


Figure 8-14 Master Arm Live Indication

AGM 65 Seeker Reference Circle

8.65 The AGM-65 Seeker Reference symbol is a circle the position of which in the HUD corresponds to the commanded LOS of the missile seekerhead in the AGM-65G only. The Seeker Reference circle for the AGM-65B remains fixed around the aim point/designated target when uncaged. It is displayed when an AGM-65 program is selected and the missile on the currently selected station has reached the "ready" state.

Target Designate Box

8.66 In the A/A and NAV master modes when the radar is tracking a target the Target Designator symbol, (a 25 milliradian box) is displayed, positioned over the target. When the radar LOS exceeds that of the HUD FOV, the target designator box is FOV limited and a digital readout of the radar LOS is displayed immediately inboard of the limited box, cueing the pilot as to the angular displacement of the target from the radar boresight.

LCOS Aiming Reticle

8.67 During radar tracking, the LCOS Aiming Reticle is a 35 milliradian circle with a 1 milliradian pipper. During Stadiametric ranging the LCOS Aiming Reticle is composed of a variable diameter stadiametric range circle and pipper. The size of the stadiametric circle is controlled by the NAS based on the selected target wingspan and the Stadiametric Range Trim Control on the throttle, the maximum and minimum diameters being determined by the target size at 300 and 2400 feet.

CCIL Aiming Reticle

8.68 During radar tracking the CCIL Aiming Reticle is composed of an 8 milliradian circle with a 1 milliradian pipper. In Stadiametric operation, it is a variable diameter circle with a pipper, and functions as per the LCOS aiming reticle.

CCIL Bullet Trajectory Flight Line

8.69 The CCIL Aiming Reticle is positioned along the BTFL at the intersection of the bullet time-of-flight and the radar measured target range. Time of flight marks are placed along the bullet path at 0.5 second intervals. The BTFL indicates the last 1.75 seconds of bullet flight.

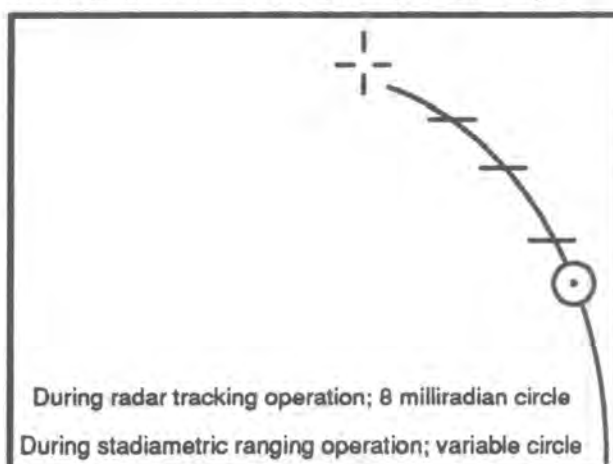


Figure 8-15 CCIL Symbology

A/A Guns Range

8.70 In A/A Guns a Target Range scale is displayed in the upper right HUD FOV, with preset range cues at 600, 1500, and 2400 feet. Actual range (radar or stadiametric) is shown by the caret on the scale. With radar ranges greater than or equal to 2700 feet the caret is pegged at the top of the scale.

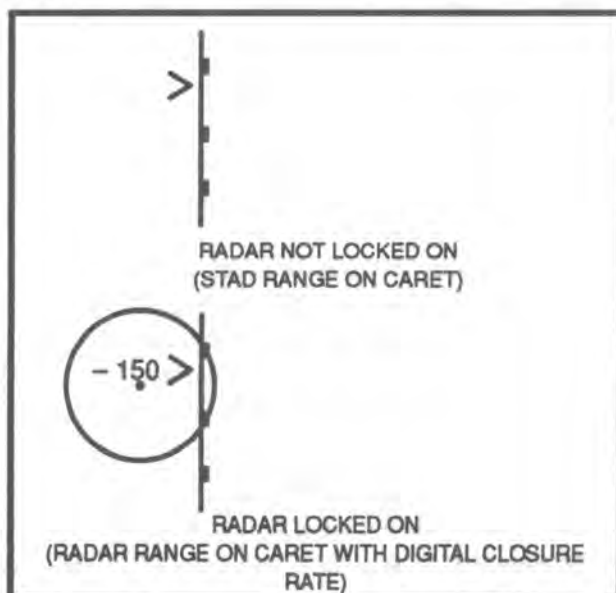


Figure 8-16 A/A Guns Range To Target Symbology

Closure Rate

8.71 Closure Rate, in knots, is displayed digitally adjacent to the range caret when the radar is tracking. Positive numbers indicate an overtake on the target, and negative closure rates indicate the range is increasing.

AIM-9L Reference Circle

8.72 The AIM-9L Reference Circle is a boresighted 65 milliradian circle and is displayed in the A/A missile mode.

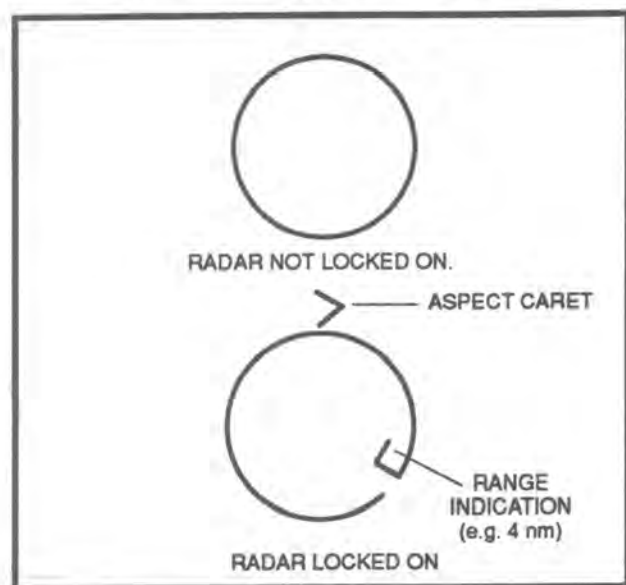


Figure 8-17 AIM-9L Missile Reference Circle Symbolology

Target Range Marker

8.73 The break and hook on the AIM-9L Reference circle indicates target range. Each mile is represented by an o'clock position; e.g. 6 nm = 6 o'clock. The Target Range Marker is only displayed if the target range is less than 12 nm.

Target Aspect Caret

8.74 The Target Aspect Caret is fixed at the 12 o'clock position of the AIM-9L reference circle, and rotates through 360 degrees to represent the projection of the target's velocity vector in the attack aircraft's X-Y plane. With the Target aspect Caret pointing up, the target aircraft has the same heading as the tracking aircraft. With the aspect caret pointing to 3 o'clock the target will track left to right across the attacking aircraft's FOV.

AIM-9L Line Of Sight

8.75 The AIM-9L Line of Sight symbols are displayed at the current position of the seeker head. When the radar is not locked on, and the missile is not self tracking a heat source, the missile LOS is boresighted and centred inside the AIM-9L Reference circle. The missile LOS will be

cued to the radar LOS following lock on. There are two modes for displaying the missile LOS symbols, either self-track enabled (circles) or self-track not enabled (crosses). The symbol size increases when missile audio is above the preset threshold. A small "X" is displayed when self track is disabled and the audio tone is below the threshold. When the audio goes above the threshold, a larger "X" is displayed. The symbol changes to a small circle when self-track is enabled and missile audio is below the threshold. When the tone exceeds the threshold, the symbol changes to a large circle. The symbol changes to a diamond when the missile enters the self track condition.

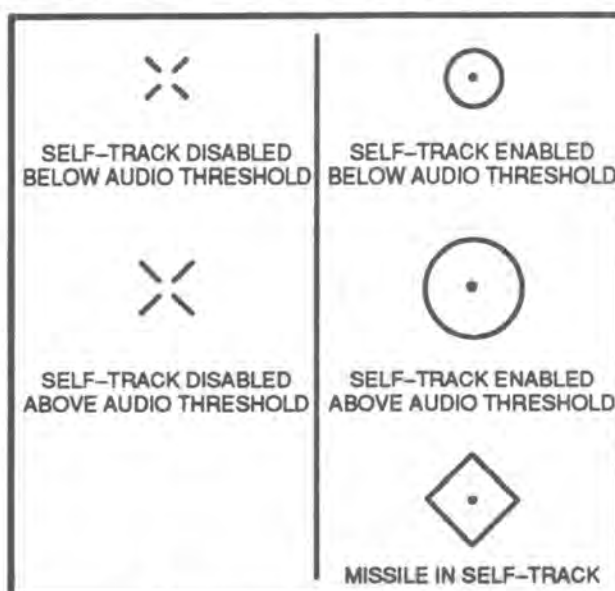


Figure 8-18 AIM-9L Missile Line Of Sight Symbolology

AIM-9L Launch Envelope Range Scale

8.76 The AIM-9L Launch Envelope Range Scale on the right of the AIM-9L reference circle, has two fixed launch range cues which are positioned near the top and bottom of the scale to represent the maximum (Rmax, top cue) and minimum (Rmin, lower cue) ranges at which the missile can intercept the target. The NAS generated manoeuvre (Rmev) cue is positioned between Rmax and Rmin dependent on missile launch and target performance parameters, and represents the minimum range at which the target can perform the specified escape manoeuvre and avoid the missile.

8.77 The escape manoeuvre is defined as a turn to tail aspect at a minimum of 9G, followed by an acceleration at 2/3G to a minimum velocity of 1500 feet per second.

8.78 The target range caret is placed at a position proportional to the range to the target. The closure rate, in knots, is displayed on the left side of the range to target caret. If target range is less than Rmin, the breakaway cross is displayed. If there is no radar lock, the caret, Rmev cue and closure rate are not displayed.

AL 5(0)

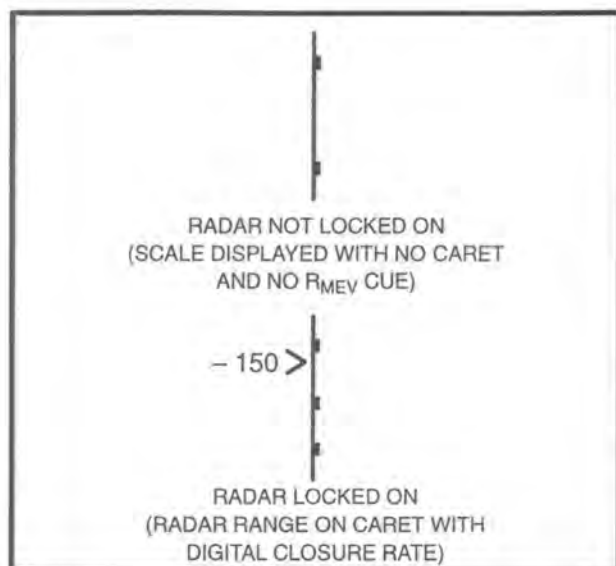


Figure 8-19 AIM-9L Missile Launch Envelope Range Scale

Intercept Steering Pointer

8.79 The Intercept Steering Pointer is displayed in the A/A Missile mode following radar lock on. It shows the change in aircraft heading required to establish collision course intercept geometry with the target aircraft.

Steering Caret

8.80 In A/G the TAE caret provides steering commands to fly the aircraft to the current destination, just as it does in the nav master mode. When the pickle button is pressed, the steering caret is removed and a steering bar is displayed. Upon release of the pickle button, the TAE caret reappears and provides direct course steering commands to fly back to the target area for re-attack. When re-attack mode is cancelled, it again provides steering commands to fly the aircraft to the selected destination.

Steering Bar

8.81 A Steering Bar replaces the TAE caret, post designate, and is laterally positioned to represent the TAE steering command, the null of which is the FPM in azimuth.

8.82 The ADI vertical pointer repeats the steering commands presented by either the HUD steering bar or the HUD steering caret which ever is displayed. If no HUD steering symbol is displayed, the ADI vertical pointer is parked out of view.

Sleuable ACM Scan Pattern

8.83 In the A/A Mode, pressure on the HOTAS slew control selects the sleuable (roll and pitch stabilized) ACM scan pattern, which is initially centred at zero degrees

azimuth and elevation, and upon selection the scan pattern symbol is presented in the HUD. The centre of the scan pattern is a circle which moves both in azimuth and elevation with respect to the fixed symbol position.

Targeting Sensor Selection

8.84 The aircraft's position relative to the HUD aimpoint is represented internally by the LOS angle depression (from horizontal) and the height above the aimpoint. The primary sensor, the radar AGR, supplies slant range to the aimpoint, which is converted to height above aimpoint. The other sensors are the radar altimeter, which supplies height above ground directly, and the system altitude, which supplies height above aimpoint when a manually specified target elevation is subtracted. Thus height above aimpoint is the measurement variable that is common to all the targeting sensors.

8.85 The NAS automatically selects the sensor for determining height above target with a priority of radar AGR, then radar altimeter, and then system altitude. The pilot can select a lower priority sensor through control of the radar mode and the radar altimeter switch. If the radar is not in the AGR mode or does not have a valid range, then it is not used. An invalid range is declared when the radar antenna is at the gimbal limits or when the aircraft roll exceeds 20 degrees. Similarly, if the radar altimeter switch is not in WPNS or does not have a valid height, then it is not used. System altitude is always available but must have a good estimate of target elevation above sea level for subtraction to be of value.

8.86 Whenever AGR is giving a valid range, it is used to compute the aimpoint's elevation above sea level, through an associated smoothing filter. Once an AGR computed target elevation is determined, it is maintained as the priority target elevation and used in subtraction from baro-inertial altitude for a period of 3 seconds. Thus, any valid AGR, however short a time, suffices to capture an aimpoint elevation, for a fixed target, for a reasonable time. If however, the radar continues to furnish valid AGR ranges, the latest data continues to update the aimpoint elevation and will be more accurate as the range becomes shorter and/or at a steeper grazing angle.

8.87 The radar altimeter height above ground can be used when the radar AGR is not available or is not suitable. It provides height above the ground below the aircraft, which can represent a good height above the target in even terrain. Similar to the radar AGR, it is used to compute a target elevation which will be maintained for 3 seconds and used for subtraction from system altitude should there be any signal dropout.

8.88 System altitude provides a height above target when an inserted target elevation is subtracted from it. The inserted target elevation is obtained from the A/G program page for visual delivery modes and from the nav data base for the planned toss delivery mode. It is used whenever the two ranging sensor based methods are not valid.

8.89 The sensor in use is indicated on the HUD by the presence or absence of a character around the flight path marker as shown in Figure 8-20.

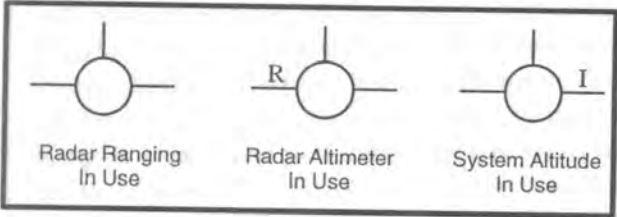


Figure 8-20 Sensor In Use Indications

Data Windows in A/G Master Mode

8.90 With NAV selected on the NAS Panel INU switch and A/G selected on the Master Mode switch, the following data is displayed in the data windows:

L1	See Table 8-2	R1	See Table 8-2
L2	See Table 8-2	R2	BRG/DIST WRT REFERENCE
L3	GND SPD, DRIFT	R3	ETA AT REFERENCE
L4	TIME OF DAY	R4	WIND DIRECTION /VELOCITY

NOTE

BRG/DIST WRT REFERENCE in data window R2 is replaced by an AGM 65 “time of uncaged operation” timer (zero to 9:59 min.) whenever an AGM 65 program is selected and the priority missile is uncaged.

Data Windows In A/A Master Mode

8.91 With NAV selected on the NAS Panel INU Switch and A/A selected on the Master Mode Switch, the following data is displayed in the data windows:

L1	See Table 8-3	R1	See Table 8-3
L2	See Table 8-3	R2	BRG/DIST WRT REFERENCE
L3	(blank)	R3	ETA AT REFERENCE
L4	TIME OF DAY	R4	(blank)

Data Window Parameter Definitions

8.92 Data window parameter definitions are shown in Table 8-4.

Table 8-2 Definition of L1, L2, R1 and R2 in A/G Master Mode

MODE		NAV PANEL REFERENCE SWITCH		
		NAS	NAVAID ¹	OFST NAVAID ¹
A/G BOMBS	L1	PRG #, DELIVERY TYPE	--	--
	L2	#WPNS, TYPE, ARMING ³	--	--
	R1	SLANT RANGE TO TARGET (FT)	--	--
	R1	RDR TARGET RANGE (NM) ²	--	--
	R2	BRG/DIST TO REFERENCE	BRG/DIST FROM NAVAID	BRG/DIST FROM OFFSET NAVAID
AGM 65	L1	PRG #, DELIVERY TYPE	--	--
	L2	AGM TYPE, PRIORITY, POLARITY ³	--	--
	R1	SLANT RANGE TO TARGET (FT)	--	--
	R1	RDR TARGET RANGE (NM) ²	--	--
	R2	BRG/DIST TO REFERENCE	BRG/DIST FROM NAVAID	BRG/DIST FROM OFFSET NAVAID
	R2	AGM 65 TIMER ⁴	--	--
A/G RKTS	L1	PRG #, DELIVERY TYPE	--	--
	L2	# PODS, TYPE, R/S ³	--	--
	R1	SLANT RANGE TO TARGET (FT)	--	--
	R2	BRG/DIST TO REFERENCE	BRG/DIST FROM NAVAID	BRG/DIST FROM OFFSET NAVAID
A/G GUNS	L1	PRG #, DELIVERY TYPE	--	--
	L2	"GUNS" ³	--	--
	R1	SLANT RANGE TO TARGET (FT)	--	--
	R2	BRG/DIST TO REFERENCE	BRG/DIST FROM NAVAID	BRG/DIST FROM OFFSET NAVAID
A/G FLARES	L1	PRG #	--	--
	L2	# PODS, "FLARE" ³	--	--
	R1	CSE TYPE, WPT	"FIX"	"FIX"
	R2	BRG/DIST TO REFERENCE	BRG/DIST FROM NAVAID	BRG/DIST FROM OFFSET NAVAID
¹ A dash (--) indicates that the definition listed for the NAS REFERENCE Switch setting is the same for the NAVAID and OFST NAVAID REFERENCE Switch settings. ² RDR TARGET RANGE is displayed in data window R1 in lieu of SLANT RANGE TO TARGET for either a MRTS BOMB or MRTS AGM65 program when radar lock occurs. ³ If the MANUAL WPNS switch on the Armament Panel is not in the AUTO or AGM-65 position, data window L2 shall display "MANUAL" when the A/G or A/A Master Mode is selected. ⁴ The R2 window will display AGM65 "time of uncaged operation" timer (zero to 9:59 min) whenever the priority missile is uncaged.				

Table 8-3 Definition of L1, L2, and R1 in A/A Master Mode

MODE	RADAR STATUS	
	LOCKED ON	NOT LOCKED ON
MISSILE	L1	"AA MSL"
	L2	PRIORITY STATION ¹
	R1	RDR TARGET RANGE (FT)
		(blank)
CCIL	L1	"AA CCIL"
	L2	WINGSPAN SETTING ¹
	R1	RDR TARGET RANGE (FT)
		STAD TARGET RANGE (FT)
LCOS	L1	"AA LCOS"
	L2	WINGSPAN SETTING ¹
	R1	RDR TARGET RANGE (FT)
		STAD TARGET RANGE (FT)
¹ If the MANUAL WPNS switch on the Armament Panel is not in the AUTO or AGM-65 position, data window L2 shall display "MANUAL" when the A/G or A/A Master Mode is selected.		

Table 8-4 Data Window Parameter Definitions

PARAMETER	DEFINITION
A/G BOMBS PRG#	Sample Format "AGI CCIP". A program number of 0 through 9 can be displayed.
DELIVERY TYPE	Possible delivery types are CCIP, DVTS, PLTS, and MRTS.
A/G BOMBS # WPNS,	Sample Format "10x82CLO". Possible weapon types are 16, 33, 48, 82C, 82S, 83,
TYPE, ARMING	DTM;
A/G RKTS PRG #,	Possible arming is HI or LO.
DELIVERY TYPE	Sample Format "AGI CCIP"; A program number of 0 through 9 can be displayed;
A/G RKTS #PODS,	CCIP only delivery type applicable.
TYPE, R/S	Sample Format "2xRKT10R". Either 1 or 2 can be displayed for number of pods.
	Either RKT6, RKT10, or RKT16 (6, 10, 16 specifies warhead weight) can be
	displayed for type; Either R (ripple) or S (single) can be added as a suffix to type.
A/G GUNS PRG #,	Sample Format "AGI CCIP". A program number of 0 through 9 can be displayed.
DELIVERY TYPE	CCIP only delivery type applicable.
A/G FLARES PRG #	Sample Format "AGI". A program number of 0 through 9 can be displayed.
A/G FLARES #PODS,	Sample Format "1 x FLARE". Either 1 or 2 can be displayed for number of pods.
TYPE	Only FLARE weapon type applicable.
AGM65 PRG #,	Sample Format "AG1 DVTS". A program number of 0 through 9 can be displayed.
DELIVERY TYPE	Possible delivery types are DVTS, PLTS, and MRTS.
AGM65 TYPE,	Sample Format "65B #2 W"; possible types are 65B, 65 and training missiles TMB,
	TM.
PRIORITY, POLARITY	Possible priority stations are 1, 2, 4, and 5. The station number is only displayed if at
	least one missile matching the program type is fitted and is in a READY condition.
	TYPE and PRIORITY fields set to "XXX #X A" without a missile READY. The
	Contrast Polarity selection made via the "UNCAGE" switch are displayed as B(B/W),
	W(W/B), or A(AUTO).
RDR TARGET RANGE (NM)	Sample Format "10.2 NM". Range of 0 to 90.
RDR TARGET RANGE (FT)	Sample Format "8000 FT". Range of 0 to 99900, resolution 100 ft.
STADIAMETRIC TARGET	Sample Format "2000 FT". Range of 300 to 2400.
RANGE (FT)	
A/A MISSILE PRIORITY	Sample Format "STA 1". Possible priority stations are 1, 2, 4 and 5. Set to "STA X"
STATION	without a priority station.
WINGSPAN SETTING	Sample Format "WS 35 FT". Wingspan setting in feet is displayed corresponding to
	aircraft types – programmable on the MDGT. Max wingspan setting is 250 feet.

DU OPERATIONS

Weapon Inventory

8.93 A complete inventory of the current aircraft weapon load can be loaded via a DTM or manually entered using the DU.

8.94 Inventory data is manually loaded by first selecting INVENTORY on the MAIN INDEX 2/2 page (as shown in Figure 8-21). This displays the INV INDEX page which shows the currently stored configuration of each of the five stations. A HUNG legend will be displayed next to any station determined to have a hung weapon.

8.95 The following four actions are available on this page:

Clean a Station

8.96 To clean a station (i.e., remove all armament), press the soft key adjacent to the CLEAN legend followed by the soft key adjacent to the station to be cleaned. The left or right soft key can be used for station 3.

Load a Station

8.97 To load a station, press the soft key adjacent to the desired station to display the INV LOAD page for that station (shown in Figure 8-22).

NOTE

The 400G, 300G, 150G, BUDDY, LUGGAGE, RECCE and DELMAR are support type stores and can only be loaded via the DTM. No rack type or quantity is associated with these stores.

8.98 Rack type must be selected first, followed by weapon type. Selecting a weapon type displays a new page.

8.99 In the case of bombs, the new page is the INV BOMBS page. Selecting a bomb type displays the INV QUANTITY page.

8.100 In the case of rockets, the new page is the INV ROCKETS page. To load rockets; first, press the soft key adjacent to the R/S legend to indicate whether ripple (R) or single (S) fire; second, press the soft key adjacent to the 02/03 legend to indicate 5002 or 5003 type rocket pods; and third, press the soft key next to the desired rocket type. This will display the INV QUANTITY page.

8.101 In the case of missiles, the new page is the INV MISSILES page. Selecting a missile type returns the DU to the INV INDEX page. Missiles always have a quantity of one per station so the INV QUANTITY page is bypassed.

8.102 In the case of flares, no selection of a flare type is needed so the new page is the INV QUANTITY page.

8.103 The INV QUANTITY page provides a quantity selection of 1 to 6 weapons. After selection of a quantity the INV INDEX page is displayed showing the new information.

Duplicate a Station

8.104 Duplication of weapon load information of one station to another is restricted to duplicating stations 1 to 5, stations 2 to 4, and vice versa. To duplicate a station load, press the soft key adjacent to the DUPL legend, followed by the soft key adjacent to the station to be copied, followed by the soft key adjacent to the station to be copied to.

Specify TDD

8.105 To specify the presence or absence of TDDs on all bombs loaded, press the soft key below the TDD legend to toggle TDD to YES or NO.

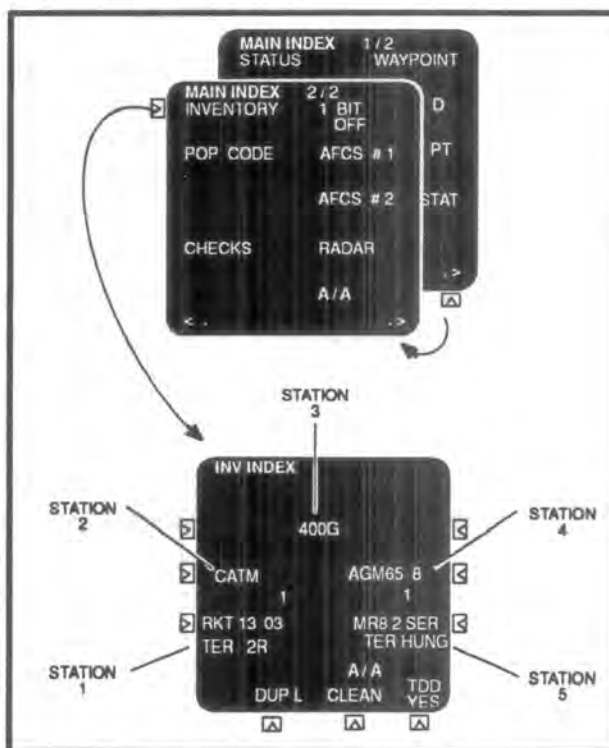


Figure 8-21 Sample Inventory Index Display

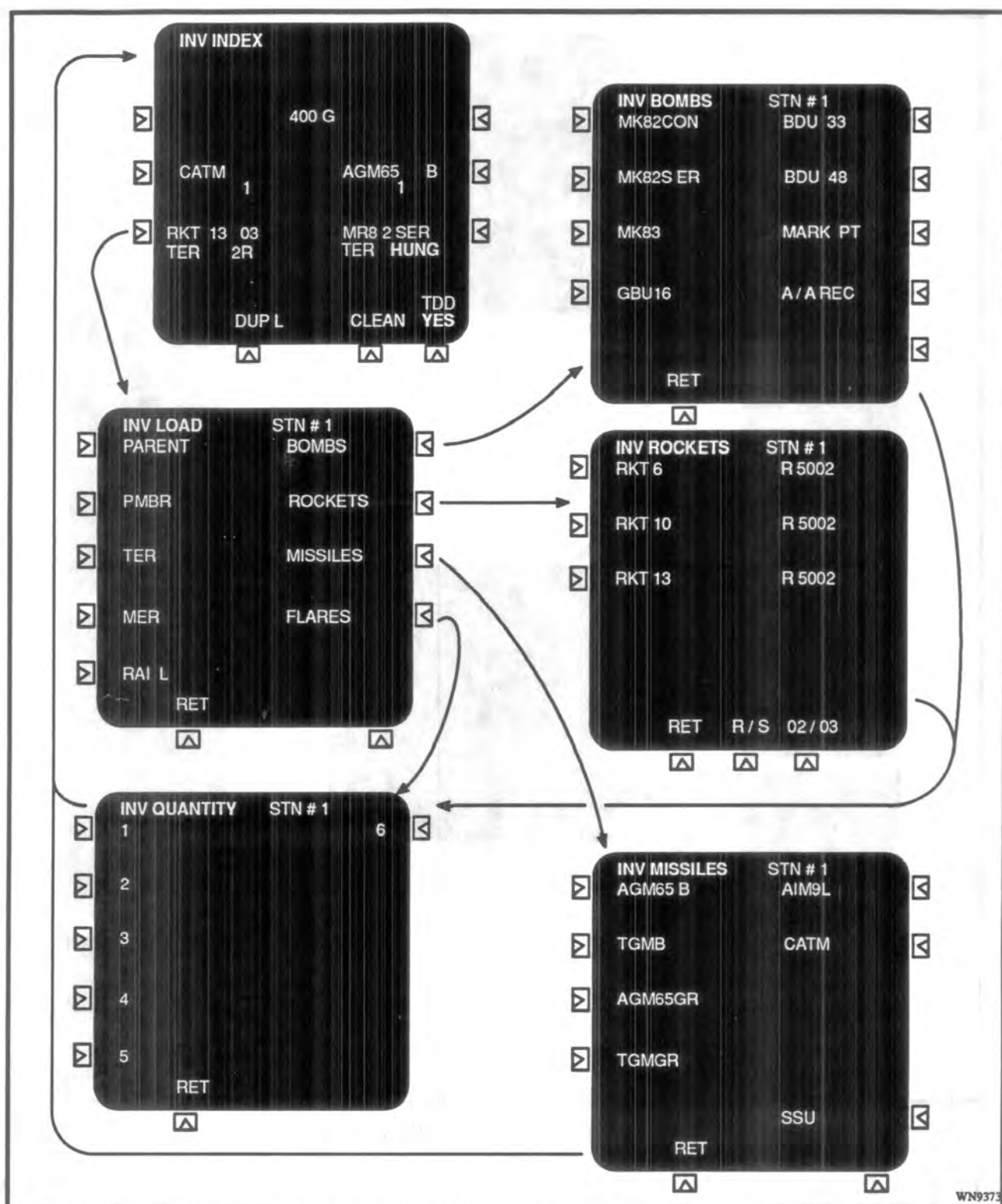


Figure 8-22 Inventory Load Displays

Program Selection

8.106 The NAS stores up to 10 A/G programs, each defining weapon type, delivery mode, target elevation, break height, quantity, ripple pattern, spacing, fusing, and arming, as applicable.

8.107 Programs are numbered 1 through 9 and 0 and only one program can be active at a time. Program 1 is the active program whenever the A/G master mode is entered.

Pressing the program change switch on the throttle activates the next sequential program. The program change switch only cycles through the first four programs. The PRG key on the UFC can be used to activate any of the ten programs. To select a program, press the PRG key, press the corresponding number key for the desired program, and press the ENT key. If the currently active program is 5, 6, 7, 8, 9, or 0, pressing the program change switch on the throttle selects program 1.

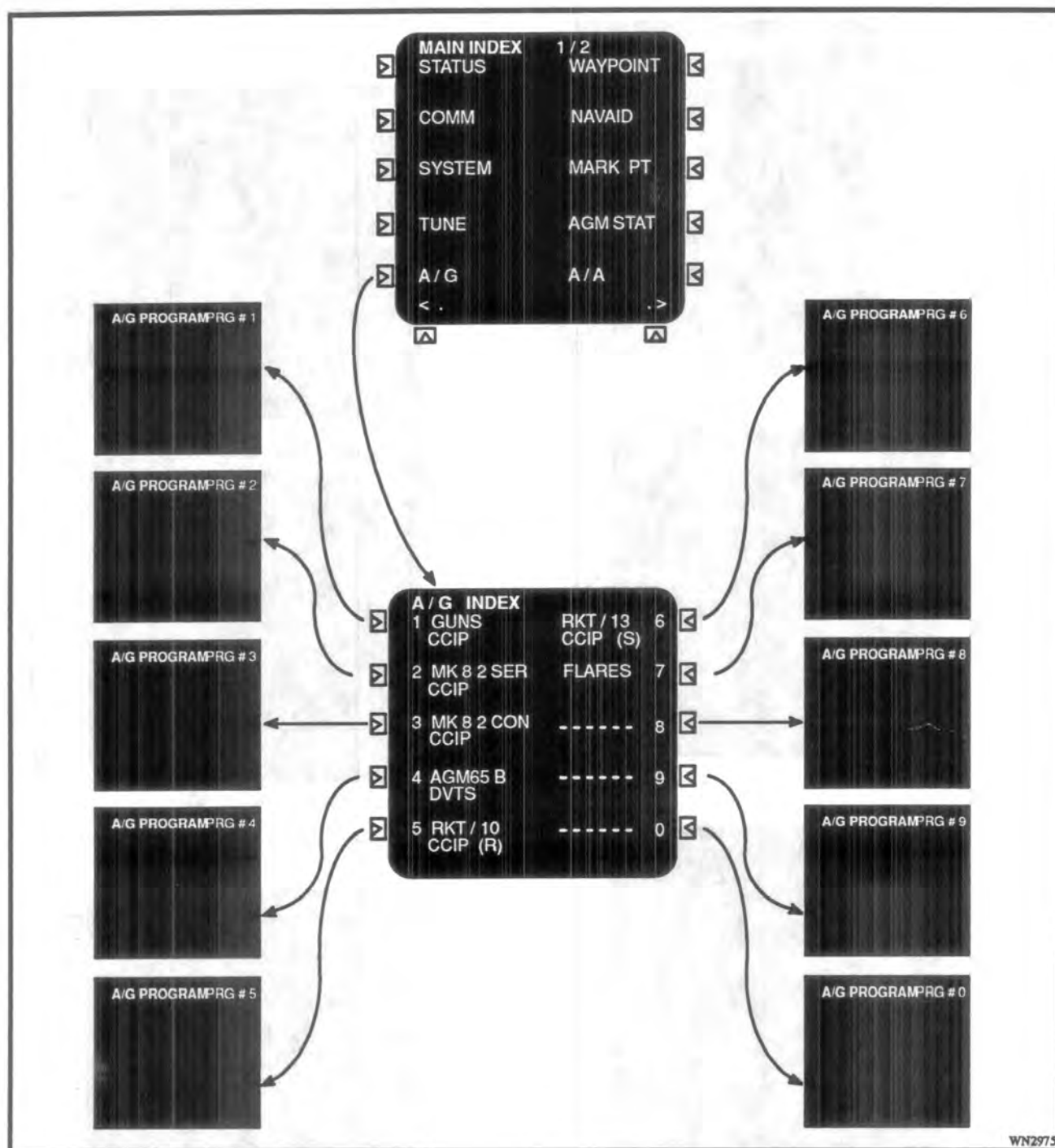


Figure 8-23 A/G INDEX Page

Program Changes

8.108 All 10 programs are set to the default program at power-on (MK82C, CCIP, ripple/single, quantity zero, 15 metre spacing, target elevation zero, break height 2900 feet, 10 sec/inst fusing, and safe arming). Programs can be altered at any time using the DU. A/G programs are manually loaded or altered by first selecting the A/G legend on the MAIN INDEX 1/2 page to display the A/G INDEX page as shown in Figure 8-23. This page shows the weapon and delivery mode currently specified in all 10 A/G programs.

8.109 Next press the soft key adjacent to the program

number to display the A/G PROGRAM page. An A/G PROGRAM page exists for each A/G program. The format of the A/G PROGRAM page varies depending on the type of weapon currently selected for that program. Figure 8-24, Figure 8-25, Figure 8-26, Figure 8-27 and Figure 8-28 each illustrate an A/G PROGRAM page for a different weapon type: bombs, missiles, rockets, guns, and flares, respectively. Although the formats vary, identical or like information is always displayed in the same location; e.g., target elevation is always shown in the upper right.

8.110 The following paragraphs describe the different fields within the A/G PROGRAM page.

AL 6(0)

Weapon

8.111 The field adjacent to the upper left soft key is the weapon used by this program. To alter the weapon, press the upper left soft key to display the A/G LOAD page. The A/G LOAD page shown in Figure 8-22 provides selection of a weapon type. To select a weapon type, press the adjacent soft key. In the case of bombs, rockets, and missiles, selection of the specific weapon is provided via the A/G BOMBS, A/G ROCKETS, and A/G MISSILES pages, respectively. To select a weapon, press the adjacent soft key. After selecting the desired weapon, the display returns to the A/G PROGRAM page and the format of the page will be for the newly selected weapon type.

Delivery Mode

8.112 The second field down on the left is the delivery mode; e.g., CCIP, DVTS, MRTS, and PLTS. This is a toggle type of field; however, for rockets, CCIP and MRTS are the only states, and CCIP is the only state for guns. This field is not applicable to flares.

Sequence

8.113 The third field down on the left is the sequence pattern. This field is applicable to bombs and rockets only. In the case of bombs, the sequence pattern is selected from the A/G SEQUENCE page displayed when the soft key adjacent to the sequence field is pressed. Selection of a sequence from the A/G SEQUENCE page returns the display to the A/G PROGRAM page. In the case of rockets, the sequence pattern field is a toggle type of field, toggling between RIPPLE fire and SINGLE fire.

Quantity

8.114 The fourth field down on the left is the quantity of bombs to be released or the number of rocket or flare pods to be fired. This field is not applicable to missiles and guns. In the case of bombs, the quantity of bombs to be released is entered via the A/G QUANTITY page, which is displayed when the soft key adjacent to the quantity field is pressed. After entry of a quantity, the display returns to the A/G PROGRAM page. In the case of rockets and flares, the number of pods field is a toggle type of field, toggling between TWO PODS and ONE POD.

Space

8.115 The fifth field down on the left is the space between bombs field. This field is applicable to bombs only. Pressing the soft key adjacent to this field displays the A/G SPACE page. The A/G SPACE page provides for entry of bomb impact point spacing in metres for each program. After entry of bomb spacing, the display returns to the A/G PROGRAM page.

Target Elevation

8.116 The field adjacent to the upper right soft key is the target elevation field. For bombs and missiles with a delivery mode of PLTS, the target elevation field is blank because target elevation is obtained from the nav data base. For all other cases, pressing the soft key adjacent to this field displays the A/G TGT ELEV page providing for entry of target elevation in feet above sea level. After entry of target elevation, the display returns to the A/G PROGRAM page.

Break Height

8.117 The second field down on the right is the break height field. This field is not applicable to flares. Pressing the soft key adjacent to this field displays the A/G BREAK page providing for entry of a break height in feet above ground level. After entry of break height, the display returns to the A/G PROGRAM page.

Fusing

8.118 The third field down on the right is the fusing field which is toggle type field, applicable to bombs only. The toggle states are 10.0/INST, 5.5/INST, 10.0/DLY, 5.5/DLY, and SAFE.

Arming

8.119 The fourth field down on the right is the arming field which is also a toggle type field, applicable to bombs only. The toggle states are HI DRAG, LO DRAG, and SAFE. If 5.5 fusing is selected in the fusing field, HI DRAG is skipped over in the toggling sequence.

Armament Live

8.120 If the MASTER ARM switch is in the ARM position, the word LIVE is displayed in the upper centre of the A/G PROGRAM page.

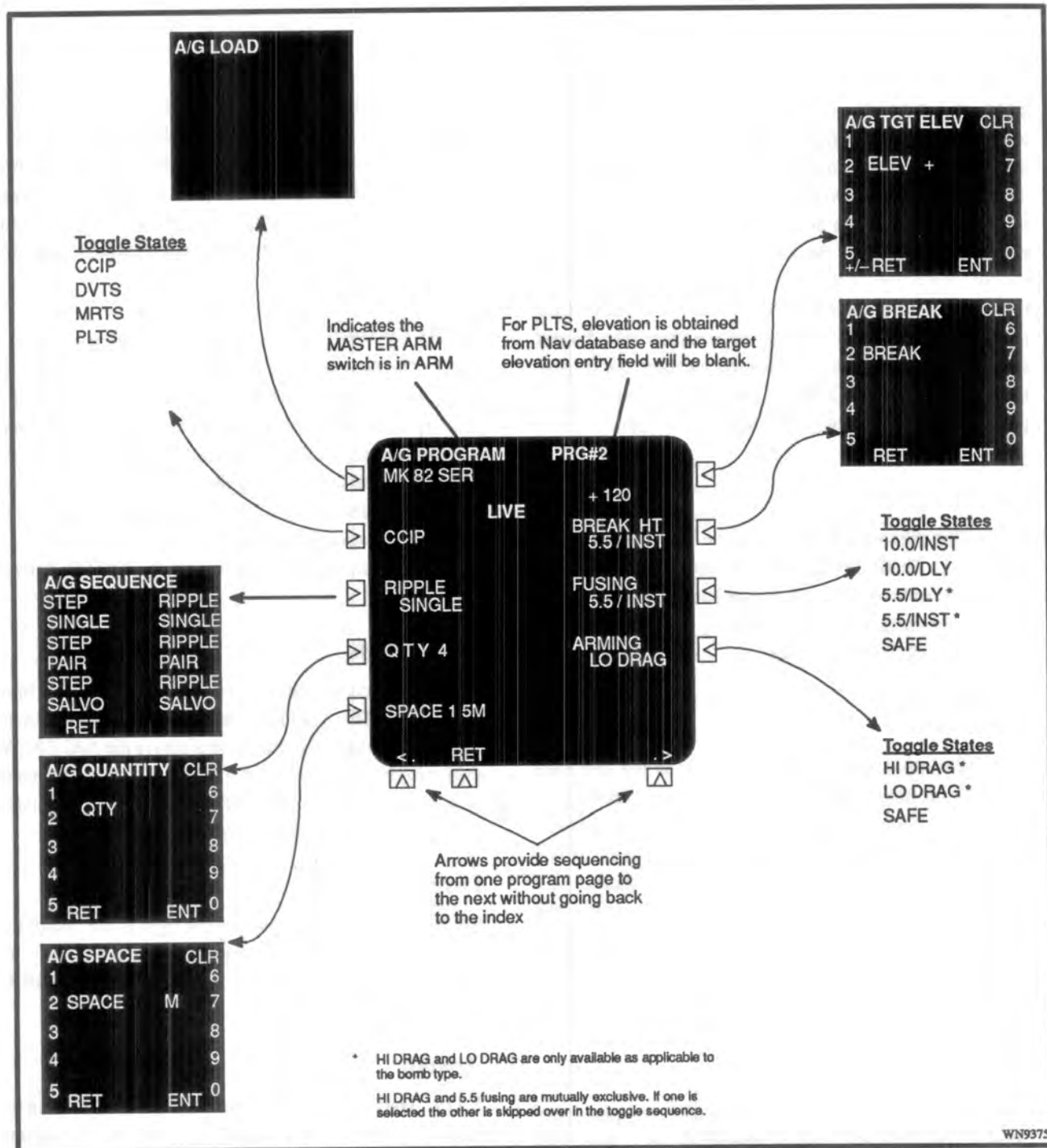


Figure 8-24 A/G PROGRAM Page (Bombs)

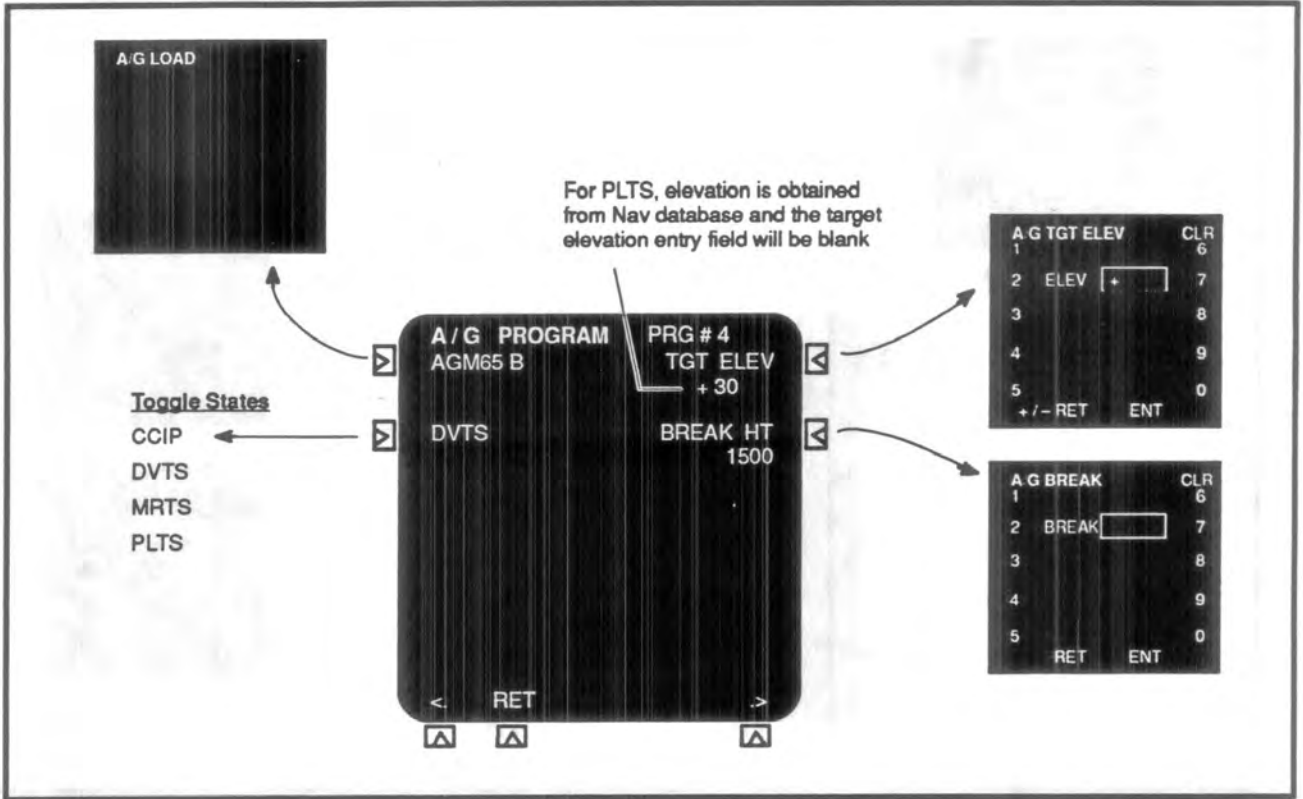


Figure 8-25 A/G PROGRAM Page (Missiles)

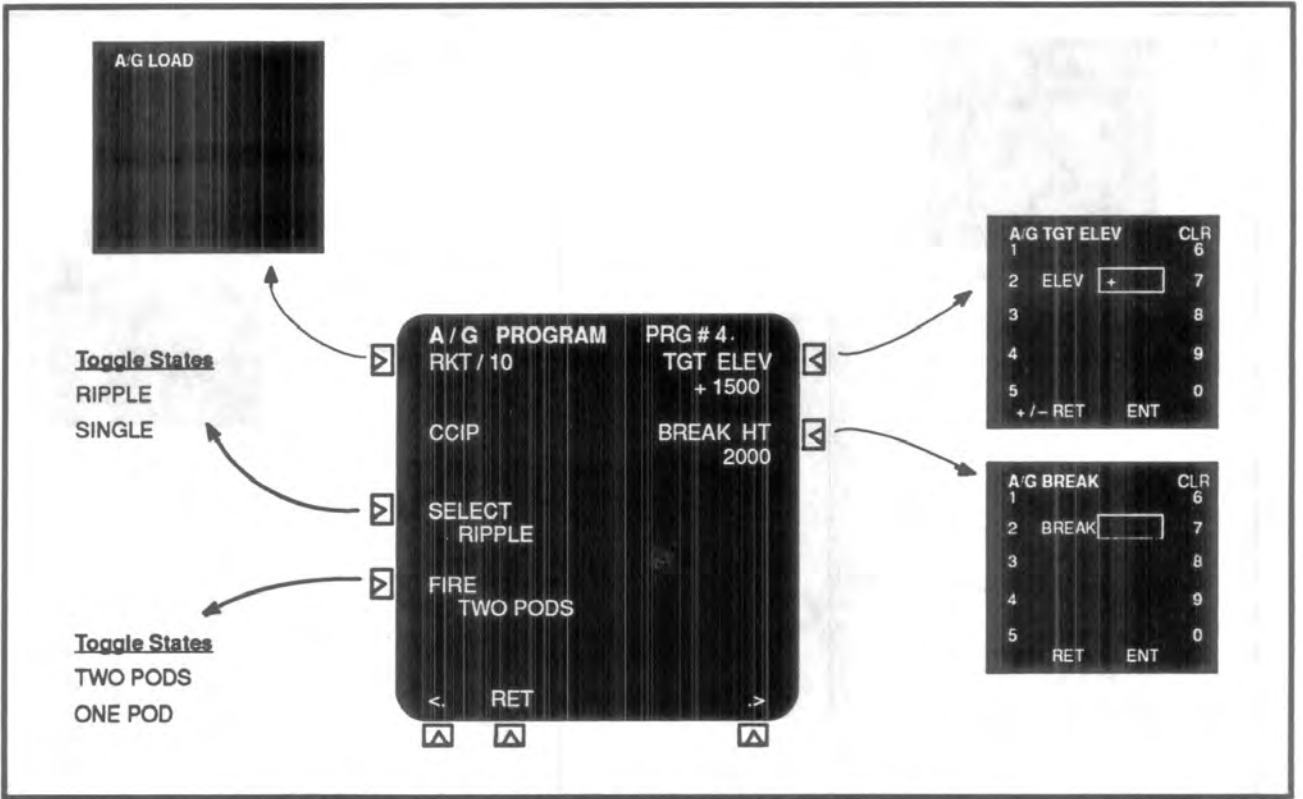


Figure 8-26 A/G PROGRAM Page (Rockets)

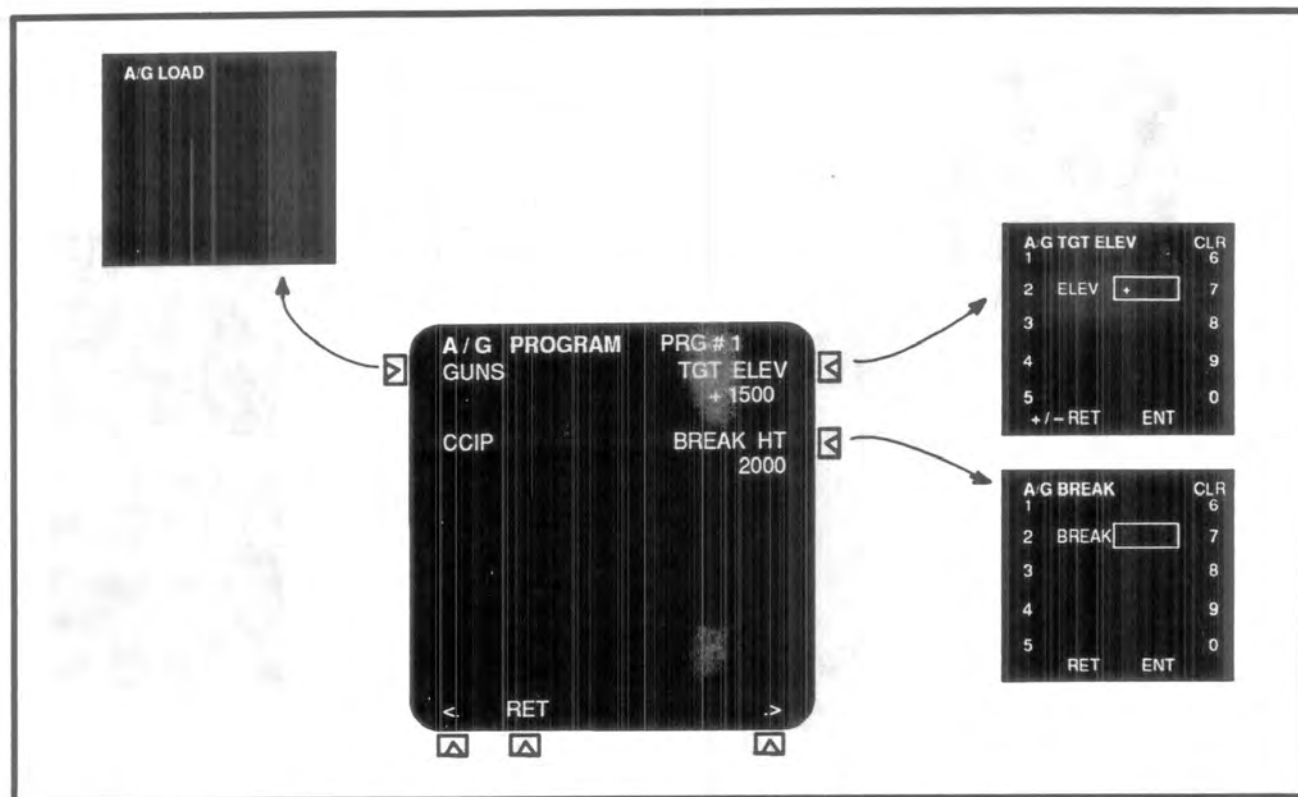


Figure 8-27 A/G PROGRAM Page (Guns)

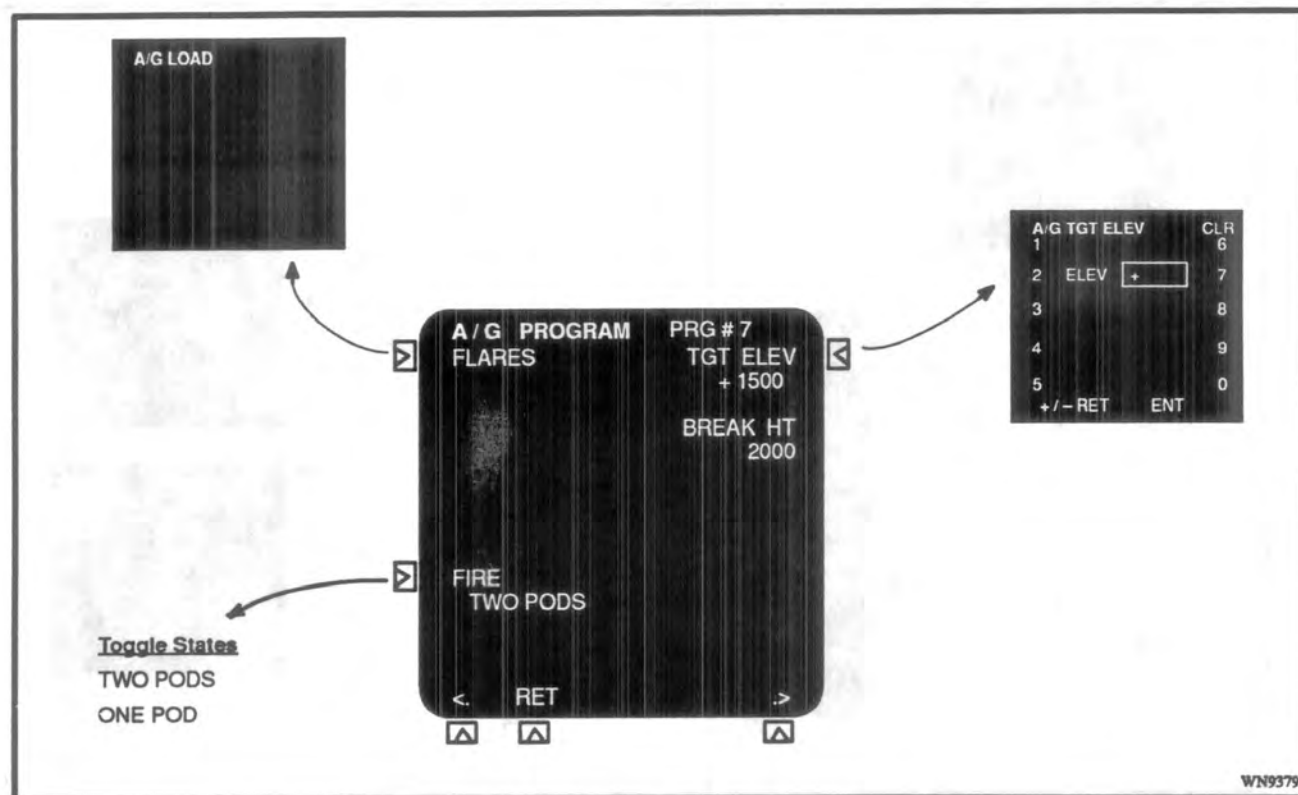


Figure 8-28 A/G PROGRAM Page (Flares)

RADAR WARNING SYSTEM (RWS)

INTRODUCTION

8.121 The AN/ALR-66(VE) is a computer-controlled Radar Warning System which performs automatic detection and display of all radar signals in the E through J band environment. To receive radar signals in this band, the system utilizes four wideband antennas mounted orthogonally on the aircraft. Nominal beam width of the antenna is 90 degrees in both the azimuth and elevation planes. Data from the surrounding electromagnetic environment is collected, analyzed, and displayed on a CRT panel.

NOTE

The ALR-66(VE) Frequency band coverage differs from standard definitions that will be observed in other publications as follows:

	<u>ALR-66(VE)</u>	<u>Standard</u>
E/F	2-4 GHz	2-4 GHz
G/N	4-8 GHz	4-8 GHz
I	8-12 GHz	8-10 GHz
J	12-18 GHz	10-20 GHz

8.122 The RWS consists of the following equipment:

- Digital Display Unit
- Control Panel
- Processor
- Power Supply
- Antennas
- Amplifier Receivers

DIGITAL DISPLAY UNIT

8.123 The CRT provides a visual indication of emitter identification by alphanumeric symbols, along with

bearing and estimated range information. The symbols appear on the CRT display in a position corresponding to the direction (angle-of-arrival) of the detected emitter signal, and at a distance from the centre of the display proportional to the estimated range. The centre of the display corresponds to your aircraft position. The distance from the centre of the display indicates estimated range for known emitters and relative signal strength for unknown emitters. The range rings equate to approximately 5, 10 and 30+nm for known emitters.

Controls

8.124 The display unit has two intensity controls. The top control, labelled CRT INT, is used to adjust symbol intensity and the bottom control, labelled PNL INT, adjusts edge lighting.

RWS CONTROL PANEL

8.125 The RWS control panel (Figure 8-29) located on the right console provides all the control functions for the ALR-66(VE) system.

Mode Switch

8.126 A three position rotary switch is used to activate the power supply and to execute a BIT on the system.

- OFF** – Isolates power from the system.
- BIT** – Initiates a complete built-in test sequence.
- ON** – Selects full system operation, in addition, the overheat alarm, power monitor, and central processor failure monitor are continuously operating in all modes. Any abnormal condition is reported on the CRT display.



Figure 8-29 RWS Control Panel

Table 8-5 RWS CRT Symbology

Symbol	Condition	Pilot Action
ON	TR function is selected, no emitter symbols are displayed, and no equipment failures are detected.	None
F	FR function is selected.	None
S	SS function is selected.	None
SA	SA function is selected.	None
LIM	System has displayed the maximum number of emitters (15)	None. Advisory only.
XXXXXX (X=0-9) (A-F)	Display Threat Library Checksum selected.	None. Advisory only.

I-BIT Symbology

Symbol	Condition	Pilot Action
OK	BIT detected no failures.	None
XXXXXX (X=0-9) (A-F)	Threat Library Checksum failure	Turn MODE switch OFF and then BIT in attempt to clear the fault. If unsuccessful turn system OFF.
1 thru 5	BIT detected a failure in one of the units.	Turn MODE switch OFF and then ON in attempt to clear the fault. If unsuccessful, turn system OFF.
F	BIT has detected a failure in the BIT test circuits.	Continue to use the system unless other observations indicate a malfunction.

C-BIT Symbology

Symbol	Condition	Pilot Action
HT	An overheat condition has developed in the power supply or processor.	Turn MODE switch OFF . Emergency use only.
CP	RWS processor has detected a malfunction in the processor	Turn MODE switch OFF and then ON in attempt to clear the fault. If unsuccessful, turn system OFF.

NOTE

The system will still operate with a failure in the 1-4 units, however performance will be degraded in one sector; 1=45°, 2=135°, 3=235°, 4=315°. A 5 unit failure is functionally the same as a CP indication.

Function Select

8.127 The **FUNCTION SELECT** thumbwheel switches, along with the **EXECUTE** pushbutton, permit the operator to select one of four functions, each capable of displaying a different set of detected emitters. Each function code is listed below. To select a function, set the appropriate letters with the thumb wheel switches and press the **EXECUTE** pushbutton. Acknowledgment of this action is indicated by the **EXECUTED** lamp in the **ADVANCE** pushbutton illuminating. Functions are as follows:

TR – Threat Recall. View known emitters that are programmed as threats, unknown emitters with a steady or fast scan, unknown group and unknown CW emitters. The system defaults to threat recall at system power up.

FR – Friendly Recall. View known emitters that are programmed as friendly.

SA – Show All. View all emitters except unknown slow-scan emitters.

SS – Slow-Scan. View unknown slow-scan emitters and known emitters that have been programmed as slow scan (non threat) emitters.

8.128 Additionally, either of two sub-functions can be selected while still retaining the current function. The sub-function codes are listed below along with an explanation of each:

SP – Spread. Spreads out emitter symbols on the CRT display, eliminating any symbol overlap that may occur in dense signal environments. This sub-function is enabled only while the **EXECUTE** switch is held pressed. Releasing the **EXECUTE** pushbutton returns the display to the original condition.

NOTE

The system automatically spreads up to three emitters, the **SP** function is only required when more than three emitters overlap.

While in this sub-function, no new emitters will be displayed.

AA – Ambiguity Scrolling. Displays all stored emitters in the system threat library that match the detected emitter. This sub-function displays each emitter symbol matching the detected emitter for 2 seconds (highest priority threat first). This sub-function is initiated by pressing the **EXECUTE** pushbutton and terminates after the last emitter symbol is displayed and returns to the original function selected.

8.129 A further specialised function allows the threat library installed in the processor to be identified by the pilot as follows:

TP – Display Threat Library Checksum. This function can only be enabled by simultaneously depressing **ADVANCE** and **EXECUTE** and turning **MODE** from **ON** to **BIT**. Six hexadecimal number (0–9 or A–F) will be displayed. This uniquely identifies the threat library installed in the processor from the selection that may be available. The function terminates by selecting **MODE** to **ON** and the **RWS** enters **TR**.

Execute

8.130 The **EXECUTE** pushbutton initiates the selection on the **FUNCTION SELECT** switches. The **EXECUTE** pushbutton has two annunciators, **ADVANCED** and **POWER**, located above and below the **EXECUTE** legend, respectively. The **ADVANCED** annunciator illuminates when the **ADVANCE** push button is used, and during **BIT** testing. The **POWER** annunciator is lit when the **RWS** detects abnormal power supply operation. If this condition occurs, the pilot should turn the **MODE** switch **OFF** and then **ON** to attempt to clear the fault. If this is unsuccessful, he should turn the system **OFF**.

Advance

8.131 The **ADVANCE** pushbutton has two functions:

1. To advance testing when a failure is detected during a **BIT**.
2. To cancel the audio warning.

8.132 The **ADVANCE** pushbutton contains two annunciators, **EXECUTED** and **AUDIO**, located above and below the **ADVANCE** legend and illuminated in the following conditions:

- a. **EXECUTED** indicates execution of the function initiated by the pilot.
- b. **AUDIO** is lit whenever an audio tone is generated.

True/Rel Switch

8.133 The **TRUE/REL** toggle switch enables the pilot to select a true or relative bearing presentation on the CRT.

- a. **TRUE** – the top of the CRT display corresponds to magnetic North, and all symbols are displayed relative to that direction.
- b. **REL** – the top of the CRT display corresponds to the actual aircraft heading, and all symbols are displayed relative to aircraft heading as obtained from the **NAS**.

BRT Control

8.134 The control adjusts the RWS panel lighting level.

RWS PROCESSOR

8.135 The RWS processor, located in the aft engine compartment provides all the signal analysis and governs the RWS operations.

POWER SUPPLY

8.136 The power supply, located in the aft engine compartment provides the DC voltages for operation of all units in the RWS. It receives 115 volts, single phase, 400 Hz power from the AFT MON AC bus.

ANTENNAS AND AMPLIFIER RECEIVERS

8.137 Four spiral wideband antennas and amplifier receivers are used to receive signals from all directions. An antenna is mounted at the tip of each wing and on each side of the lower tail section and provides bearing accuracy within 15 degrees.

SYMBOLOLOGY

8.138 Each symbol set displayed can consist of up to three characters. While the aircraft is engaged in tight manoeuvres, extra ghost symbols may occur briefly in the same or in other quadrants. These will disappear on resumption of level flight.

System Status

8.139 System status symbology is described in Table 8-5. If more than one condition exists, the active status symbols are alternately displayed.

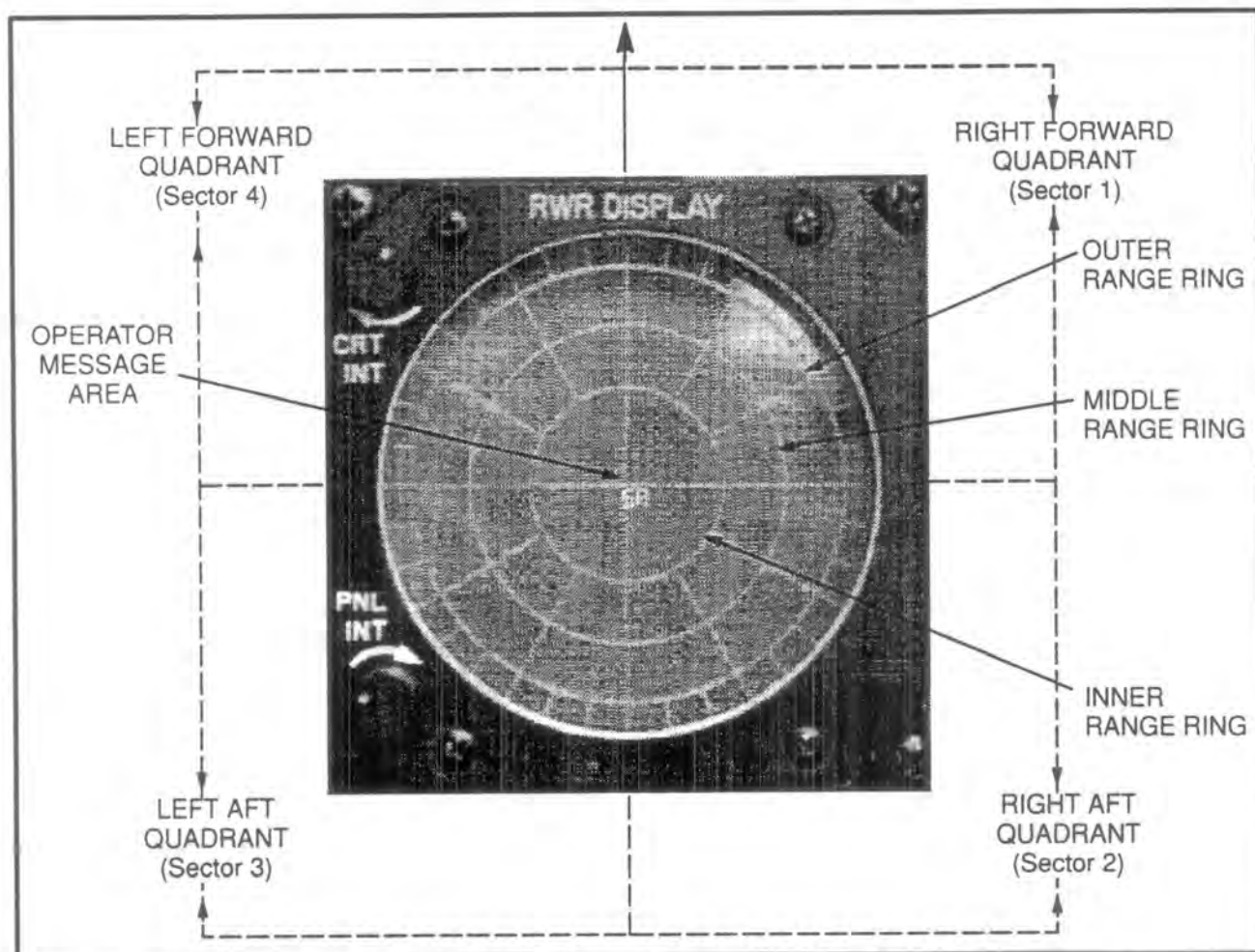


Figure 8-30 RWS Digital Display Indicator

Known Emitters

8.140 Symbols used to indicate known emitters (i.e., emitters whose operating characteristics match those stored for an emitter in the system threat library), are user defined. In the case of an ambiguity (characteristics of two or more stored emitters match the characteristics of a detected emitter), an ambiguity symbol (+) is displayed.

NOTE

In some situations (e.g. close flybys and aircraft manoeuvres in the vicinity of an emitter), multiple symbols for that emitter may appear in all quadrants of the screen momentarily. This situation will correct itself when the manoeuvre or flyby is terminated.

Unknown Emitters

8.141 For unknown emitters (i.e., emitters whose operating characteristics are not programmed in the system threat library), the displayed symbol consists of a combination of up to two characters, which corresponds to the PRI range and RF band of that emitter.

Table 8-6 Unknown Emitter Display Symbols

First Character (PRI Range)		Second Character (RF Band)	
Display Symbol	PRI	Display Symbol	RF Band
0	<200 usec	1	E/F
1	200-300 usec	2	G/H
2	300-400 usec	3	I
3	400-500 usec	4	J
4	500-700 usec		
5	700-900 usec		
6	900-1200 usec		
7	1.2-1.5 msec		
8	1.5-2 msec		
9	2-4 msec		
CW	CW Emitter		
↗ G	Group Emitter (Guidance Pulse Groups)		

Emitter Symbol Blink Rate

8.142 Each emitter symbol blinks at a rate that is related to the emitters priority status as designated in the system software. For steady illuminators (i.e., the radar signal is not scanning), fast scanning track radars, group and CW emitters, the symbol is blinked four times per second. For lower priority threats the symbol will blink two times per second. If the emitter is scanning slowly (search radar), i.e. a very low priority threat, the symbol is steady (not blinking). Any programmed emitter can be allocated any blink rate.

Emitter Symbol Priority

8.143 Out of all the emitters being tracked by the system, the computer selects the 15 highest priority emitters for display. Symbol priority is determined by the emitter's identity. A steady illuminator is considered a higher priority than a fast-scan emitter, which in turn is considered higher in priority than a slow-scan emitter. Effectively seven different priorities may be allocated using variations of tone and blink rate. Any programmed emitter can be allocated any priority.

Audio Tone

8.144 An audio alert tone is sounded for a 5-second period each time a newly detected threat emitter (i.e., known emitter classified as threat, unknown emitter with a steady or fast scan, group or a CW emitter) is displayed. The audio alert tone is sounded even if the current ALR-66 mode is not displaying threat emitters. There are three types of tone available depending on threat priority.

High Priority – two tone warble.

Mid Priority – single on/off/on tone.

Low Priority – no tone.

Automatic Antijamming

8.145 A special automatic operating mode is provided to prevent degradation of system operation in the presence of jamming signals. When in the normal operating mode, the ALR-66 continuously monitors its own performance. When degraded performance is detected, which is caused by the presence of jamming signals, the system automatically counters the effect of the jamming on its performance by raising its system sensitivity threshold above the jamming signal level. This threshold adaptation is done selectively in the RF band where jamming occurs. When jamming disappears, the system automatically adapts itself to its maximum overall sensitivity level.

RWS BUILT IN TEST

8.146 To initiate a complete BIT sequence of the RWS, select the MODE switch to **BIT**. A processor simulated signal provides a test from the receivers to the displays and the results are displayed on the CRT and audio system within 10 seconds. A successful RWS BIT is shown in Figure 8-31. The CRT displays a status code in the centre of the display indicating a faulty unit number, a BIT hardware failure, threat library checksum failure, or no failures detected. A description of BIT symbology is at Table 8-5.

NOTE

To successfully complete RWS BIT, the Radar Altimeter must be selected **OFF**.



Figure 8-31 Successful RWS BIT Test Display

NORMAL OPERATION

BIT Check

- MODE switch **BIT**
- If OK is not displayed in the centre of the RWS indicator:
 - MODE switch **OFF BIT**
- If OK still not displayed:
 - MODE switch **OFF**

An OK legend displayed in the centre of the RWS indicator display indicates no failures detected by BIT.

Initialise RWS

- MODE switch **ON**

1. RWS indicator displays the word **ON** in the centre of the display. The TR mode is initially active.

2. When a new threat emitter is detected, an audio tone sounds for 5 seconds and the AUDIO lamp lights for 5 seconds.

- TRUE / REL Switch As desired

Select A Function

- FUNCTION
SELECT switches Select desired function (TR for threat recall, FR for friendly recall, SA for show all, and SS for slow scan)
- EXECUTE switch Press
 - RWS indicator shows selected function.

Spread Display

- FUNCTION SELECT Switches SP
- EXECUTE switch Press and hold for viewing

Initiate an Ambiguity Scroll

- FUNCTION SELECT switches AA
- EXECUTE switch Press

If the RWS Indicator Displays HT in the Centre

- MODE switch **OFF**
 - If this indication occurs, the RWS has detected an overheat condition.

If the RWS indicator Displays CP in the Centre

- MODE switch **OFF/ON**
- If CP is still present:
 - MODE switch **OFF**
 - If this indication occurs, the RWS has detected abnormal central processor operation.

If the POWER Lamp on the RWS Control Panel Lights

- MODE switch **OFF/ON**
- If POWER lamp still lit:
 - MODE switch **OFF**
 - If this indication occurs, the RWS has detected abnormal power supply operation.

COUNTER MEASURE DISPENSING SYSTEM

8.147 The AN/ALE-39 CDS can store and dispense a total of 60 countermeasures consisting of chaff, flares and expendable jammers. A throttle-mounted chaff/flare switch commands the CDS to eject the selected load either individually or in preset patterns.

8.148 The CDS consists of the following units:

- a. Controller
- b. Programmer
- c. Dispenser Housings and Modules
- d. Sequencer Switches
- e. Pin Flag Switch
- f. Chaff/Flare Initiate Switch
- g. Chaff Ground Test Switch

CONTROLLER

8.149 A Controller mounted on the forward cockpit right hand console contains the system power switch, mode select buttons, a set of mechanical counters which display the number of payloads remaining, and a switch for the emergency ejection of all remaining flares.

Salvo Flare On/Off Switch

8.150 This is a three position toggle switch which functions as follows:

- a. ON/OFF – controls power to the controller and programmer
- b. SALVO FLARE – ejects all remaining flares. The switch must be pulled out before it can be lifted up over a detent and placed into this position.

NOTE

The pilot can abort the execution of a programmed sequence by toggling the ON/OFF/SALVO FLARE switch to OFF, then back to ON. This action aborts any release sequence that is in progress. The LOAD REMAINING indicators are decremented as each payload is released and so will still indicate the correct number of payloads remaining after an aborted sequence.

Mode Pushbuttons and Indicators

8.151 The Controller has 3 pushbuttons used to select the mode for each payload type. Pressing the pushbutton selects the next mode for that payload. The indicators show the current mode selected. There are 4 basic modes for each payload type as follows:

- O – OFF.
- S – SINGLE.
- P – PROGRAMMED.
- R – RWS. Not applicable to RNZAF.

8.152 In addition the following 2 modes are available for Flares:

- M – MULTIPLE.
- G – GROUP.

8.153 Table 8-7 shows the payloads discharged whenever the throttle INITIATE switch is activated, for each of the MODE pushbutton selections.

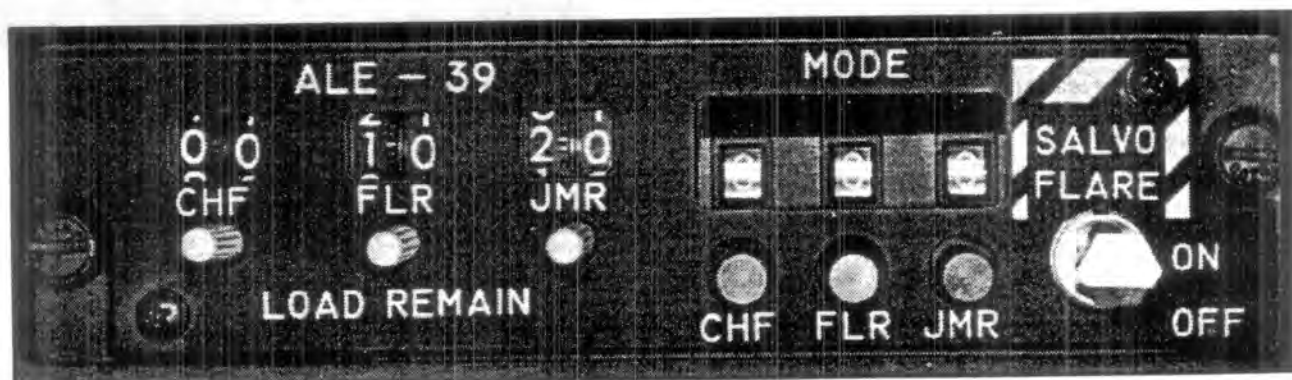


Figure 8-32 CDS Controller

Table 8-7 Mode Pushbuttons and Indicators

MODE	TYPE OF PAYLOAD		
	Chaff	Flare	Jammer
S	Single Bundle	Single Flare	Single Jammer
P	Programmed Salvo	Programmed Sequence	Programmed Sequence
M	—	Single Flare from each Module section containing flares	—
G	—	One programmed Sequence from each module section containing flares	—
SALVO/FLARE Switch	—	Immediate dispensing of All remaining flares	

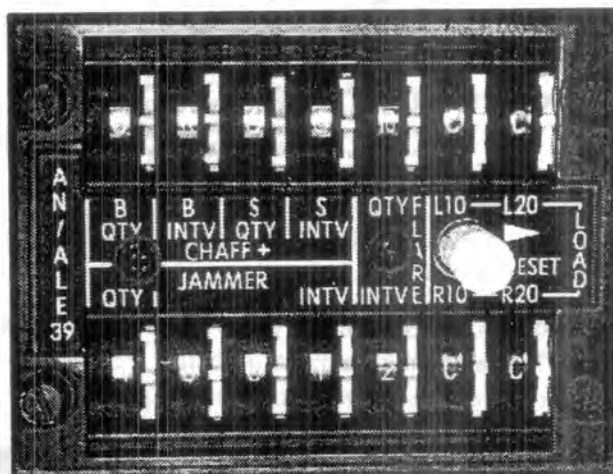
Load Remaining Indicators

8.154 The individual LOAD REMAINING indicators keep track of the number of chaff, flare and jammer payloads remaining. Each indicator has settings from 00 to 99. The indicators are set at loading to reflect the quantity of payloads remaining. As each payload is dispensed the indicator decrements one count.

Programmer

8.155 The Programmer generates control signals for both programmed and single-payload dispensing modes. Chaff, flare and jammer programs can be executed independently or concurrently, and the single dispensing mode can be selected whilst an automatic program is in progress however the automatic program will run to completion without interruption. The Programmer is located in the aft engine compartment and is programmed by the groundcrew prior to the mission.

8.156 Programmable items are the type and quantity of payload in each of 4 dispenser sections, and the sequence for each type of payload. The dispensing sequence includes the number of bursts (i.e. single firings) and the time interval between bursts. Additionally, chaff sequences include the number of salvos within a sequence and the time interval between salvos. Programmable options are shown in Table 8-8 (ALE-39 Programmable Options).



• **Figure 8-33 Programmer**

Table 8-8 ALE-39 Programmable Options

Types of Payloads	Chaff	Flares	Jammer
Burst (1)	1 2 3 4 C (2) R (3)	2 3 4 6 8 10	2 3 4
Burst intervals (seconds)	0.125 0.25 0.5 0.75 1.0 R (3)	2 (4) 4 6 8 10	1 to 299 (5)
Salvos (6)	1 2 4 6 8 10 15	None	None
Salvo intervals	2 4 6 8 10	None	None
Notes - Individual ejection of one payload - Continuous - Random - Rapid fire sequence capable of being engaged from select switches panel is provided to eject all flares sequentially with burst interval of 0.125 second. - Burst intervals are variable in 1-second increments between 1 and 299 seconds with accuracy of ± 5 percent. - Single sequence of burst.			

AL 6(0)

DISPENSER HOUSINGS AND
MODULES

8.157 A Sequencer Switch, Dispenser Housing and Dispenser Module together provide the actual ejection of countermeasure payloads. There are 2 Dispenser Housings located on the underside of the tail section (1 each side).

WARNING

Due to the possibility of fire, flares are not to be carried for training when an air-air refuelling store is carried on station 3.

CAUTION

Due to the probability of dispensed countermeasures striking it, the bobtail is to be removed from the American Electric 400 gallon centreline tank when the CDS is loaded. No such restriction applies to the Royal Industries 400 gallon tank.

NOTE

Removing the bobtail does not change the carriage or jettison limitations for the 400 gallon centreline tank.

A small drag penalty will be incurred with the bobtail removed. The exact percentage increase has not been determined.

SEQUENCER SWITCH

8.158 The Sequencer Switch is mounted on top of the Dispenser Housing and receives the eject commands from the Programmer to eject the loads.

PIN FLAG SWITCH

8.159 The Pin Flag Switch is a ground safety device located forward of the dispenser units on the left hand side of the fuselage. Inserting the pin and flag into this switch disables the dispenser circuits.

WARNING

The CDS must have a Pin Flag switch ground lock installed whenever the aircraft is on the ground with dispensers loaded, as very low stray voltages are capable of firing the impulse cartridges.

CHAFF/FLARE INITIATE SWITCH

8.160 The initiate switch is mounted on the inboard side of the throttle grip. It is a red, four-position, momentary contact switch with three active positions: forward for chaff, aft for flare, and down for jammer. Moving the initiate switch to one of these positions dispenses a payload of the corresponding type in the manner selected on the corresponding MODE indicator.

NOTE

The INITIATE switch is live whenever the aircraft is airborne, with the CDS switched ON, regardless of the position of the MASTER ARM switch.

NORMAL OPERATION

Ground

8.161 When countermeasures are loaded the AN/ALE-39 Safety Pin must be removed in the arming area prior to takeoff and installed again after landing.

Inflight

8.162 To setup the CDS controller, proceed as follows:

- ON/OFF switch ON
- LOAD REMAIN indicators Verify
- MODE controls Select required mode

8.163 To dispense chaff:
CHAFF/FLARE switch Momentarily
press forward

8.164 To dispense flares:
CHAFF/FLARE switch Momentarily
press aft

8.165 To dispense jammers:
 CHAFF/FLARE switch Momentarily
 press down

NOTE

To dispense payloads simultaneously e.g. chaff/flare you will have to initiate both the chaff and the flare switches.

8.166 To salvo eject all flares:
 ON/OFF switch Pull and lift into
SALVO FLARE
 position

8.167 To abort a dispensing sequence in progress:
 ON/OFF switch OFF then ON.

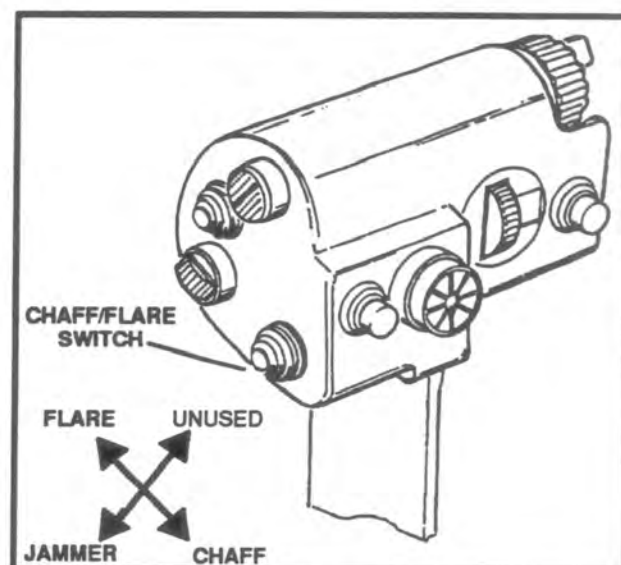


Figure 8-34 Chaff/Flare Initiate Switch

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CHAPTER 9

PERFORMANCE DATA

PAGE	PAGE
INTRODUCTION	9-1
GENERAL PERFORMANCE DATA BASIS	9-1
DRAG INDEX SYSTEM	9-3
SAMPLE PROBLEM	9-3
AIRSPEED CORRECTIONS	9-6
SAMPLE PROBLEM	9-6
Airspeed Correction for Position Error	9-6
Mach Number Correction for Position Error ...	9-6
Airspeed Conversion	9-6
ALTIMETER CORRECTIONS	9-7
SAMPLE PROBLEM	9-7
Altitude Correction for Position Error	9-7
TAKEOFF	9-14
Takeoff Charts	9-14
Operational Takeoff Distance	9-14
SAMPLE PROBLEM	9-14
Takeoff Distance – Operational	9-14
LINE SPEED CHECK	9-15
MAXIMUM TAKEOFF WEIGHT	9-15
SAMPLE PROBLEM	9-15
Maximum Takeoff Weight	9-15
Refusal Speed	9-16
SAMPLE PROBLEM	9-16
Takeoff Refusal Speeds	9-16
Stopping Distance	9-17
SAMPLE PROBLEM	9-17
Stopping Distance	9-17
MAXIMUM TAKEOFF WEIGHT A-4	9-19
MAXIMUM TAKEOFF WEIGHT TA-4	9-21
CLIMB	9-26
CLIMB	9-26
SAMPLE PROBLEM	9-26
Climb Speed Schedule	9-26
SAMPLE PROBLEM	9-26
Climb Fuel	9-26
COMBAT CEILING AND OPTIMUM CRUISE ALTITUDE	9-27
SAMPLE PROBLEM	9-27
RANGE	9-38
RANGE FACTOR CHART	9-38
Use	9-38
BINGO RANGE	9-38
TA-4K Bingo Range	
Fuel On Board Required or	
Bingo Constant Cruise	9-38
SAMPLE PROBLEM	9-39
Long Range Cruise	9-39
SAMPLE PROBLEM	9-39
Long Range Cruise	
Mach Number and EPR	9-39
Long Range Cruise – Nautical Miles per Pound of Fuel	9-39
Maximum Range Cruise	9-40
SAMPLE PROBLEM	9-40
Maximum Range Cruise	
Time and Speed	9-40
Maximum Range Cruise	
Nautical Miles Per Pound Of Fuel	9-40
Maximum Range Cruise – Fuel	9-41
NAUTICAL MILES PER POUND OF FUEL ...	9-41
SAMPLE PROBLEM	9-41
Nautical Miles Per Pound of Fuel	9-41
Nautical Miles Per Pound of Fuel	9-42
Nautical Miles Per Pound of Fuel	9-42
Nautical Miles Per Pound of Fuel	9-43
Nautical Miles Per Pound of Fuel	9-43
Nautical Miles Per Pound of Fuel	9-44
SAMPLE PROBLEM	9-44
Engine Pressure Ratio for Cruise	9-44
ENDURANCE	9-74
BINGO ENDURANCE	9-74
MAXIMUM ENDURANCE	9-74
SAMPLE PROBLEM	9-74
Maximum Endurance Speed	9-74
SAMPLE PROBLEM	9-74
Maximum Endurance Fuel	9-74
AIR REFUELLING	9-81
AIR REFUELLING CHARTS	9-81
TANKER SPEED ENVELOPE	9-81
SAMPLE PROBLEM	9-81
Tanker Speed Envelope	9-81
TANKER FUEL AVAILABLE FOR TRANSFER	9-81
SAMPLE PROBLEM	9-82
Tanker Fuel Available for Transfer	9-82
TANKER FUEL TRANSFER TIME	9-82
SAMPLE PROBLEM	9-82
Tanker Fuel Transfer Time	9-82
FUEL CONSUMPTION OF TANKER DURING AIR REFUELLING	9-83
SAMPLE PROBLEM	9-83
Fuel Consumption of Tanker	
During Air Refuelling	9-83
DESCENT	9-91
MAXIMUM RANGE DESCENT	9-91
SAMPLE PROBLEM	9-91
Descent Fuel	9-91
LANDING	9-98
LANDING	9-98
SAMPLE PROBLEM	9-98
Approach Speed	9-98
SAMPLE PROBLEM	9-99
Landing Distance	9-99

CHAPTER 9 Cont.

PERFORMANCE DATA

	PAGE		PAGE
COMBAT PERFORMANCE	9-113	SAMPLE PROBLEM 2	9-115
COMBAT PERFORMANCE	9-113	Manoeuvrability	9-115
TURNING RADIUS	9-113	MAXIMUM MACH NUMBER	9-115
SAMPLE PROBLEM	9-113	SAMPLE PROBLEM	9-115
Turning Radius	9-113	Maximum Mach Number	9-115
MANOEUVRABILITY	9-114	SAMPLE PROBLEM	9-115
SAMPLE PROBLEM 1	9-114	Military Fuel Flow	9-115
Manoeuvrability	9-114		

FIGURES

FIGURE	PAGE	FIGURE	PAGE
9-1 Drag Indexes A/TA-4K	9-4	9-31 Climb Time TA-4	9-35
9-2 Sample Airspeed Mach Number Altitude Correction For Position Error	9-7	9-32 Combat Ceiling And Optimum Cruise Altitude A-4	9-36
9-3 Sample Airspeed Conversion	9-7	9-33 Combat Ceiling and Optimum Cruise Altitude TA-4	9-37
9-4 Airspeed - Altitude - Mach Number Correction for Position Error (Cruise and Approach Power Configurations)	9-8	9-34 Sample Bingo Range Plot	9-38
9-5 Airspeed Conversion	9-9	9-35 Sample Long Range Cruise Mach Number And EPR	9-39
9-6 ICAO Standard Altitude Chart	9-10	9-36 Sample Long Range Cruise Nautical Miles Per Pound Of Fuel	9-39
9-7 Density Altitude Chart	9-12	9-37 Sample Maximum Range Cruise Time And Speed	9-40
9-8 Centigrade / Fahrenheit Conversion	9-13	9-38 Sample Maximum Range Cruise Nautical Miles Per Pound Of Fuel	9-40
9-9 Sample Takeoff Distance	9-15	9-39 Sample Maximum Range Cruise -Fuel ...	9-41
9-10 Sample Maximum Takeoff Weight	9-16	9-40 Sample Nautical Miles Per Pound Of Fuel	9-41
9-11 Sample Takeoff Refusal Speed	9-17	9-41 Sample Nautical Miles Per Pound Of Fuel	9-42
9-12 Sample Stopping Distance	9-17	9-42 Sample Nautical Miles Per Pound Of Fuel	9-42
9-13 Takeoff Distance A-4	9-18	9-43 Sample Nautical Miles Per Pound Of Fuel	9-43
9-14 Maximum Takeoff Weight A-4	9-19	9-44 Sample Nautical Miles Per Pound Of Fuel	9-43
9-15 Takeoff Distance TA-4	9-20	9-45 Sample Nautical Miles Per Pound Of Fuel	9-44
9-16 Maximum Takeoff Weight TA-4	9-21	9-46 Sample Engine Pressure Ratio For Cruise	9-44
9-17 Takeoff Refusal Speeds A-4	9-22	9-47 Range Factor Chart	9-45
9-18 Takeoff Refusal Speeds TA-4	9-23	9-48 Bingo Range	9-46
9-19 Stopping Distance A-4	9-24	9-49 Bingo Range Plot	9-48
9-20 Stopping Distance TA-4	9-25	9-50 Long Range Cruise Mach Number & EPR A-4	9-49
9-21 Sample Climb Speed Schedule	9-26	9-51 Long Range Cruise Mach Number & EPR TA-4	9-50
9-22 Sample Climb Fuel	9-27	9-52 Long Range Cruise Nautical Miles Per Pound Of Fuel A-4 ...	9-51
9-23 Sample Combat Ceiling and Optimum Cruise Altitude	9-27		
9-24 Climb Speed Schedule A-4	9-28		
9-25 Climb Speed Schedule TA-4	9-29		
9-26 Climb Fuel A-4	9-30		
9-27 Climb Fuel TA-4	9-31		
9-28 Climb Distance A-4	9-32		
9-29 Climb Distance TA-4	9-33		
9-30 Climb Time A-4	9-34		

CHAPTER 9 Cont.

PERFORMANCE DATA

FIGURES

FIGURE	PAGE	FIGURE	PAGE
9-53	Long Range Cruise – Nautical Miles Per Pound Of Fuel TA-4	9-75	Tanker Fuel Available For Transfer TA-4
	9-52	9-76	Tanker Fuel Transfer Time A-4
9-54	Maximum Range Cruise – Time And Speed A-4	9-77	Tanker Fuel Transfer Time TA-4
	9-53	9-78	Fuel Consumption Of Tanker During Air Refuelling A-4
9-55	Maximum Range Cruise – Time And Speed TA-4		9-89
	9-54	9-79	Fuel Consumption Of Tanker During Air Refuelling TA-4
9-56	Maximum Range Cruise – Fuel A-4		9-90
9-57	Maximum Range Cruise – Fuel TA-4	9-80	Sample Descent Fuel
	9-58	9-81	Descent Fuel A-4
9-58	Nautical Miles Per Pound Of Fuel A-4	9-82	Descent Fuel TA-4
	9-60	9-83	Descent Distance A-4
9-59	Nautical Miles Per Pound Of Fuel TA-4	9-84	Descent Distance TA-4
	9-66	9-85	Descent Time A-4
9-60	Engine Pressure Ratio For Cruise A-4	9-86	Descent Time TA-4
9-61	Engine Pressure Ratio for Cruise TA-4	9-87	Sample Approach Speed
9-62	Sample Maximum Endurance Speed	9-88	Sample Landing Distance
9-63	Sample Maximum Endurance Fuel	9-89	Approach Speed A-4
9-64	Bingo Endurance	9-90	Approach Speed TA-4
9-65	Maximum Endurance Speed A-4	9-91	Landing Distance
9-66	Maximum Endurance Fuel A-4	9-92	Sample Turning Radius
9-67	Maximum Endurance Speed TA-4	9-93	Sample Manoeuvrability
9-68	Maximum Endurance Fuel TA-4	9-94	Sample Maximum Mach Number
9-69	Sample Tanker Speed Envelope	9-95	Sample Military Fuel Flow
9-70	Sample Tanker Fuel Available For Transfer	9-96	Turning Radius
	9-82	9-97	Manoeuvrability
9-71	Sample Tanker Fuel Transfer Time	9-98	Maximum Mach Number
9-72	Sample Tanker Fuel Consumption During Air Refuelling	9-99	Military Fuel Flow A-4
	9-83	9-100	Military Fuel Flow TA-4
9-73	Tanker Speed Envelope		9-125
9-74	Tanker Fuel Available For Transfer A-4		9-126
	9-85		

TABLES

TABLE	PAGE
9-1	Abbreviations, Symbols, And Definitions
	9-2

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CHAPTER 9

PERFORMANCE DATA

INTRODUCTION

9.1 The operating data charts contained in this section provide the pilot with information enabling him to realize the maximum performance capabilities of the aircraft. All the data presented in this section is stored in the Mission Data Ground Terminal which is the primary means for pre-flight planning. Hence this section should be used as a manual backup only.

9.2 Chapter 9 is divided into several parts to present performance data in proper sequence for manual preflight

planning. Some of the performance data is identical for both A-4 and TA-4. Where this is not the case, separate charts have been provided for each type.

9.3 Sample problems and charts are provided to present the sequence of steps required to find the proper values and solution of a given problem. Performance data is presented in graphical type charts for ICAO standard day conditions. In some instances, temperature corrections for nonstandard atmosphere have been included.

GENERAL PERFORMANCE DATA BASIS

9.4 Performance data is based on aircraft characteristics obtained from Navy and contractor flight tests on A-4F and TA-4F aircraft, calculations, and engine data from Pratt and Whitney specifications. All charts are presented for ICAO standard atmosphere conditions, although ambient temperature correction scales are

provided in a number of charts where temperature effects are significant. All performance is based on a centre of gravity position of 25 percent MAC. All charts are applicable to JP-4 or JP-5 fuel, having a nominal density of 6.5 and 6.8 pounds per gallon respectively.

Table 9-1 Abbreviations, Symbols, And Definitions

Abbreviation	Definition	Abbreviation	Definition
a/a_0	Ratio of speed of sound at altitude to speed of sound at sea level, ICAO standard day	M	Mach number
AC	Alternating Current	MAX	Maximum
ADF	Automatic Direction Finding	min	Minutes
Alt.	Altitude	mm	Millimeter
°C	Degrees Centigrade	μ	Coefficient of rolling friction
CAS or V_c	Calibrated airspeed = IAS corrected for position error	NMI	Nautical Miles
CG	Center of Gravity	OAT	Outside air temperature
DC	Direct Current	P	Static atmospheric pressure at any altitude
Deg	Degrees	P_0	Static atmospheric pressure at sea level ICAO standard day – 29.92 inches of mercury
EAS or V_e	Equivalent airspeed = CAS corrected for compressibility effect	psi	Pounds per square inch
EGT	Exhaust gas temperature	RCR	Runway condition reading
EPR	Engine pressure ratio	RNI	Reynolds number index
°F	Degrees Fahrenheit	rpm	Revolutions per minute (Engine speed)
Flt	Flight	SL	Sea level
FPM or fpm	Feet per minute	Std	Standard
Freq	Frequency	T	Static absolute temperature at any altitude
Ft or ft	Feet	T_0	Static absolute temperature at sea level ICAO standard day = 288.2 degrees Kelvin
g	Gravity force	TAS	True airspeed
H or h	Altitude	Vol	Volume
Hg	Mercury	Wt	Weight
hr	Hour	Δ	Delta – change in (e. g. gross weight)
IAS or V_i	Indicated airspeed = instrument reading corrected for instrument error	δ or P/P_0	Delta – ratio of static air pressure to ICAO standard sea level static air pressure
ICAO	International Civil Aviation Organization	ρ	Rho – density of atmosphere in slugs/ foot at any altitude
In	Inches	ρ_0	Rho – density of atmosphere at sea level ICAO standard day = 0.002378 slugs per foot
KCAS	Knots calibrated airspeed	σ or ρ/ρ_0	Sigma– ratio of density of any altitude to density at sea level, ICAO standard day
KEAS	Knots equivalent airspeed	θ or T/T_0	Theta – ratio of absolute temperature of altitude to absolute temperature at sea level. ICAO standard day
KIAS	Knots indicated airspeed	any	
KTAS	Knots true airspeed		
Kn/Kts	Knots		
lb	Pounds		
$\geq$	Greater than or equal to		

DRAG INDEX SYSTEM

9.5 The large variety of possible external store loadings permitted on the A/TA-4 requires a suitable method of performance data presentation. This method, called the Drag Index System, permits the presentation of performance data for a number of external store loadings on one chart, greatly reducing the number of charts required.

9.6 In the Drag Index System, each item of the external store configuration, such as a bomb, tank, pylon or multiple bomb adapter, is assigned a drag number whose value depends on the size and shape of the item and its location on the aircraft. The summation of these individual drag numbers, for a particular loading, defines the drag index for that configuration. This index, when applied to the performance charts, defines the performance of that configuration.

9.7 The individual store drag numbers used for determining the drag indexes are shown in Figure 9-1. Note that the drag numbers for a given store depend on the store station on which they are carried. An "X" in a drag index column of Figure 9-1 indicates that the noted store is carried on that particular station but the drag index number is not available at time of publication. The weights of the external stores, pylons, tanks, and adapters are also included in Figure 9-1. The drag of the clean aircraft (drag index = 0) includes the drag of the centreline pylon but no guns or wing pylons.

SAMPLE PROBLEM

9.8 Assume the external configuration consists of a 300-gallon Aero-1D fuel tank on the centreline pylon, a 5x300 pound MK 81 Snakeye bomb cluster on each inboard wing pylon, and a 500-pound MK 82 bomb on each outboard wing pylon.

External Store Item	Drag Index
2-MK12 20mm guns and ammunition	7.0
1 - 300-gallon Aero -1D fuel tank on centreline	15.0
2 - inboard wing pylons	12.0
2 - outboard wing pylons	14.0
2 - MER-7 multiple bomb adapters	46.0
2 - 5x300 pound MK 81 Snakeye bombs	70.0
2 - 500-pound MK 82 bombs	6.0
Total Drag Index	<u>170.0</u>

9.9 As the mission is flown, tanks may be dropped and stores will be expended changing the external store configuration and thus the drag index.

1. After the centreline fuel tank is dropped:

External Store Item	Drag Index
2 - MK12 20mm guns	7.0
2 - inboard wing pylons	12.0
2 - outboard wing pylons	14.0
2 - MER-7 multiple bomb adapters	46.0
2 - 5x300 pound MK 81 Snakeye bombs	70.0
2 - 500-pound MK 82 bombs	6.0
Total Drag Index	<u>155.0</u>

2. After the centreline fuel tank is dropped and the bombs are expended:

External Store Item	Drag Index
2 - MK 12 20mm guns	7.0
2 - inboard wing pylons	12.0
2 - outboard wing pylons	14.0
2 - MER-7 multiple bomb adapters	46.0
Total Drag Index	<u>79.0</u>

Page 9-4

GUNS AND SUSPENSION EQUIPMENT			APPROX WEIGHT LB/EA	DRAG INDEX AT STORE STATION:				
				1	2	3	4	5
TWO MK 12 GUNS AND 200 ROUNDS AMMO			457			7		
200 ROUNDS 20 mm AMMO			142					
ONE AERO-20A RACK-PYLON			68		6		6	
ONE AERO-20A RACK-PYLON			64	7			7	
AERO-1A ADAPTER								
AERO-2A LAUNCHER								
AERO-5A LAUNCHER ADAPTER			99	7	7	7	7	7
A/A 37B-3 PMBR			87					
TER-7			105		12	12	12	
MER-7			223		23	23	23	
LAU-24/A LAUNCHER								
MK 51 BOMB RACK								
TANKS AND PODS(1)	SUSPENSION	NO. OF STORES						
150 GAL FUEL TANK; FULL/EMPTY(2)	AERO-20A,-7A	1	1156/136 (1111)		10	10	10	
300 GAL FUEL TANK (BOBTAIL); FULL/EMPTY(2)	AERO-7A	1	2223/183 (2133)			15		
300 GAL FUEL TANK (FINNED) FULL/EMPTY(2)	AERO-20A	1	2239/199 (2149)		14		14	
400 GAL FUEL TANK; FULL/EMPTY(2)	AERO-7A	1	2960/240 (2840)			20		
3)								
300 GAL REFUELLING STORE; FULL/EMPTY(2)	AERO-7A	1	2765/725 (2675)			30/119 (3)		
GTC-85 POD- MOUNTED; FULL/EMPTY	AERO-20A,-7A	1	700/650		19	21	19	

NOTE

1. Refer to the A-4/TA-4 Tactical Manual, for all other applicable external store drag index and weight data, carriage and release limitations, and exceptions for carriage of the stores weighing more than station limitations noted on sheet 1.
2. Full tank weight for JP-5 fuel, JP-4 in parentheses.
3. Hose and drogue: retracted/extended.
4. Drag index does not include drag index of suspension equipment for above items.

Figure 9-1 Drag Indexes A/TA-4K (Sheet 2 of 2)

AIRSPEED CORRECTIONS

9.10 Several corrections to the airspeed indicator reading must be added to arrive at the true airspeed of the aircraft. Two corrections, peculiar to the indicator, are instrument error and lag. These errors, which are usually insignificant, are added algebraically to the indicator reading to obtain the indicated airspeed.

9.11 Calibrated airspeed is equal to the airspeed indicator reading corrected for position and instrument error. Position error, shown in Figure 9-4 is an error introduced due to the location of the static source at a point of nonambient static pressure.

9.12 Equivalent airspeed is equal to the airspeed indicator reading corrected for position error, instrument error, and for adiabatic compressible flow, compressibility correction, for the particular altitude.

9.13 True airspeed is related to equivalent airspeed by the following: $KTAS = KEAS \times \frac{1}{\sqrt{\sigma}}$

9.14 To convert calibrated airspeed to true airspeed and true Mach number, Figure 9-5 is provided. Figure 9-5 has compressibility effects reflected in the graph, permitting a direct step from calibrated to true airspeed.

9.15 A position error is associated with the Mach number indicated values and the true Mach number values. This relationship is shown in Figure 9-4.

SAMPLE PROBLEM

Airspeed Correction for Position Error

(For Figure 9-4)

- (A) Indicated airspeed 350 Kts
- (B) True pressure altitude 20,000 ft
- (C) ΔV - Correction to be added 3 Kts
- Calibrated airspeed 353 Kts

Mach Number Correction for Position Error

(For Figure 9-4)

- (D) Indicated Mach number 0.74 M
- (E) ΔM - Correction to be added 0.006 M
- (F) True Mach number 0.746 M

Airspeed Conversion

(For Figure 9-5)

- (A) Calibrated airspeed 360 Kts
- (B) True pressure altitude 25,000 ft
- (C) True Mach number 0.849 M
- (D) OAT 20°C
- (E) True airspeed 565Kts

ALTIMETER CORRECTIONS

9.16 The altimeter is connected to the static source. Position error corrections, similar to those for air speed indications, must be applied to the altimeter indications to obtain true pressure altitude. The corrections are given in Figure 9-4. Instrument error and altimeter lag are also prevalent in the altimeter system. The lag error (approximately 100 feet) could be significant in a low-altitude dive pullout.

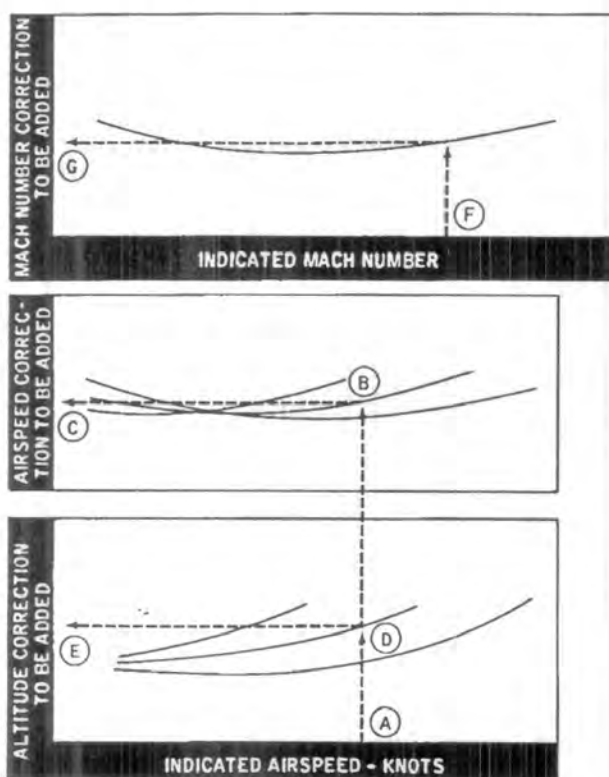


Figure 9-2 Sample Airspeed Mach Number Altitude Correction For Position Error

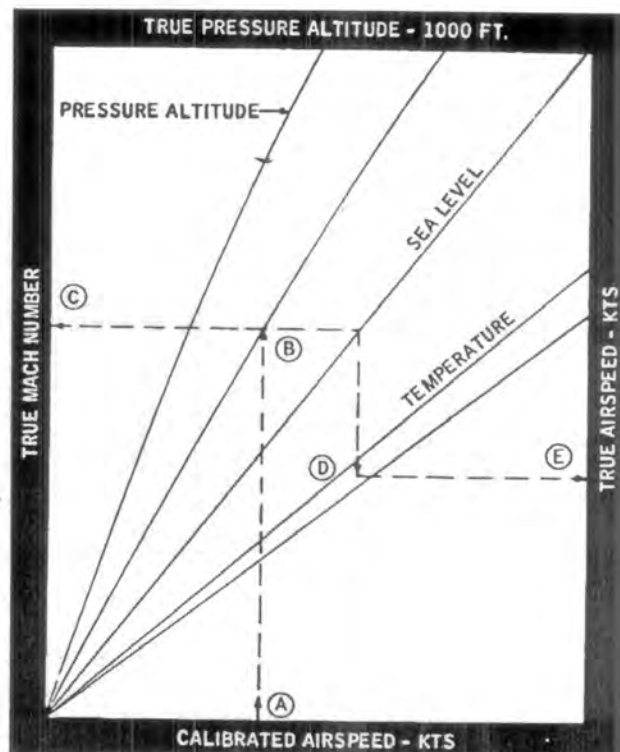


Figure 9-3 Sample Airspeed Conversion

SAMPLE PROBLEM

Altitude Correction for Position Error

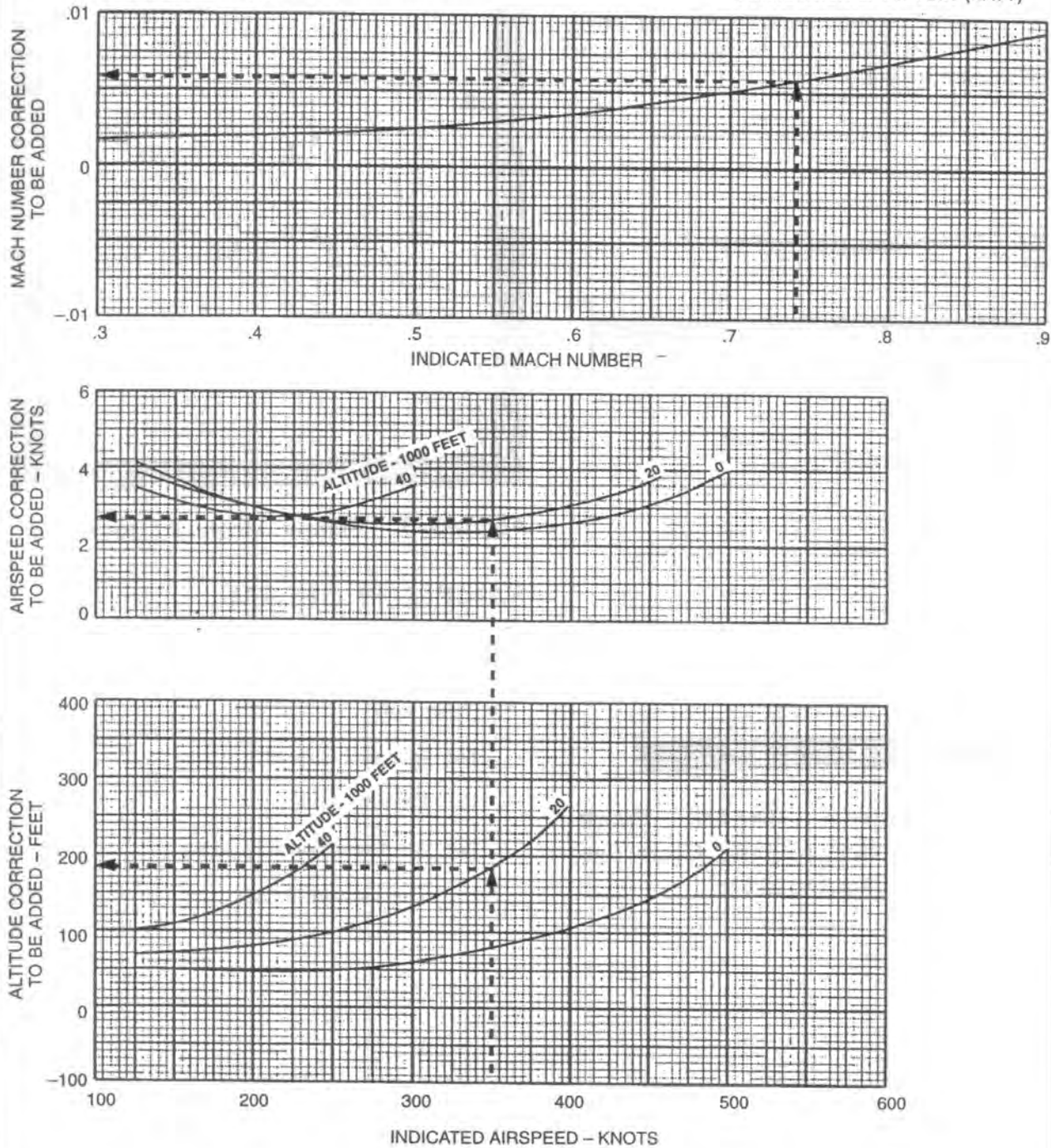
(For Figure 9-4)

- (A) Indicated airspeed 350 Kts
- (B) Pressure altitude 20,000 ft
- (C) Δh - Correction to be added 180 ft
- True pressure altitude 20,180 ft

AIRSPED - ALTITUDE - MACH NUMBER CORRECTION FOR POSITION ERROR (CRUISE AND APPROACH POWER CONFIGURATIONS)

MODEL: A-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1-SEPTEMBER 1968
DATA BASIS: FLIGHT TEST (NAVY)



**Figure 9-4 Airspeed - Altitude - Mach Number Correction for Position Error
(Cruise and Approach Power Configurations)**

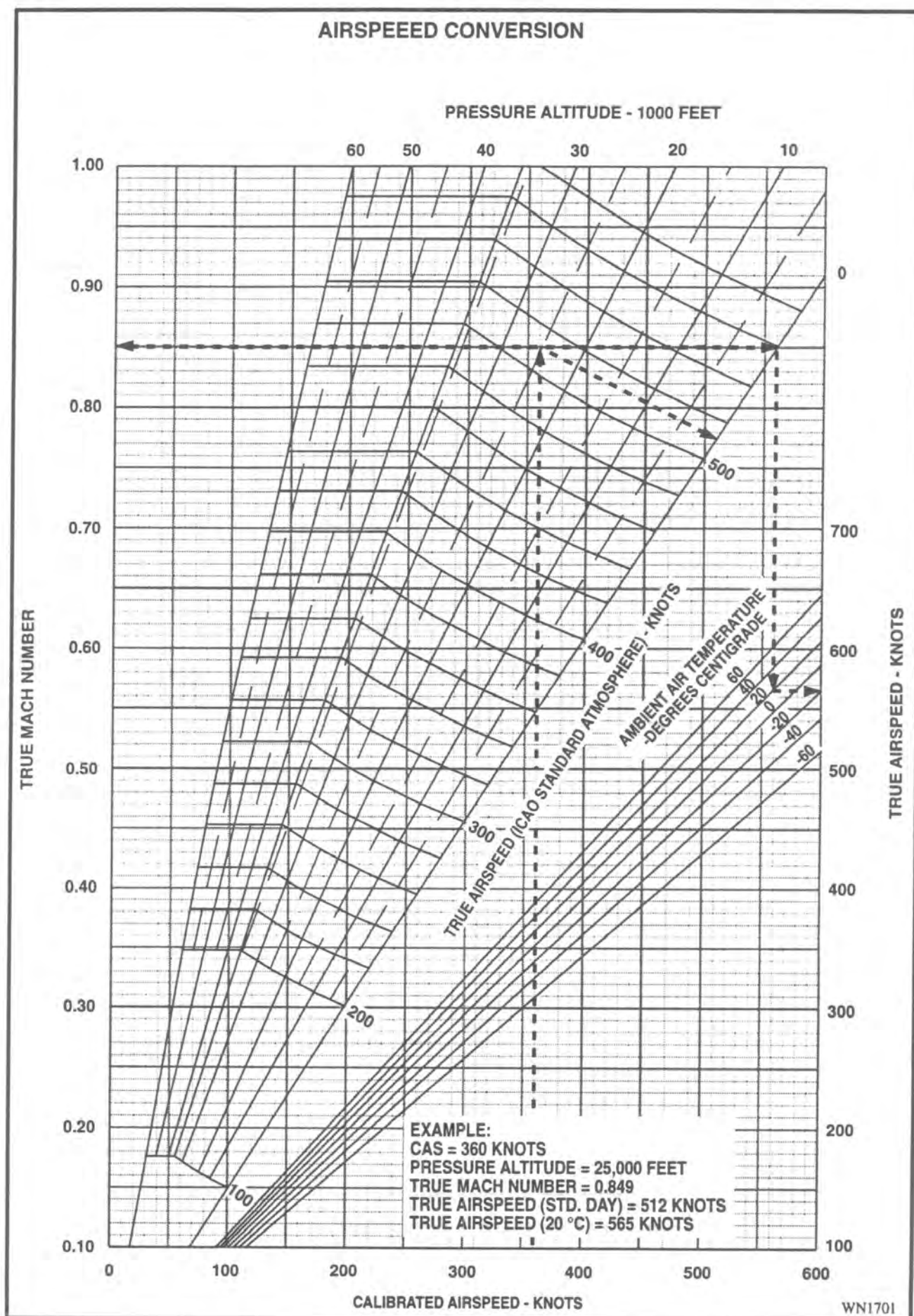


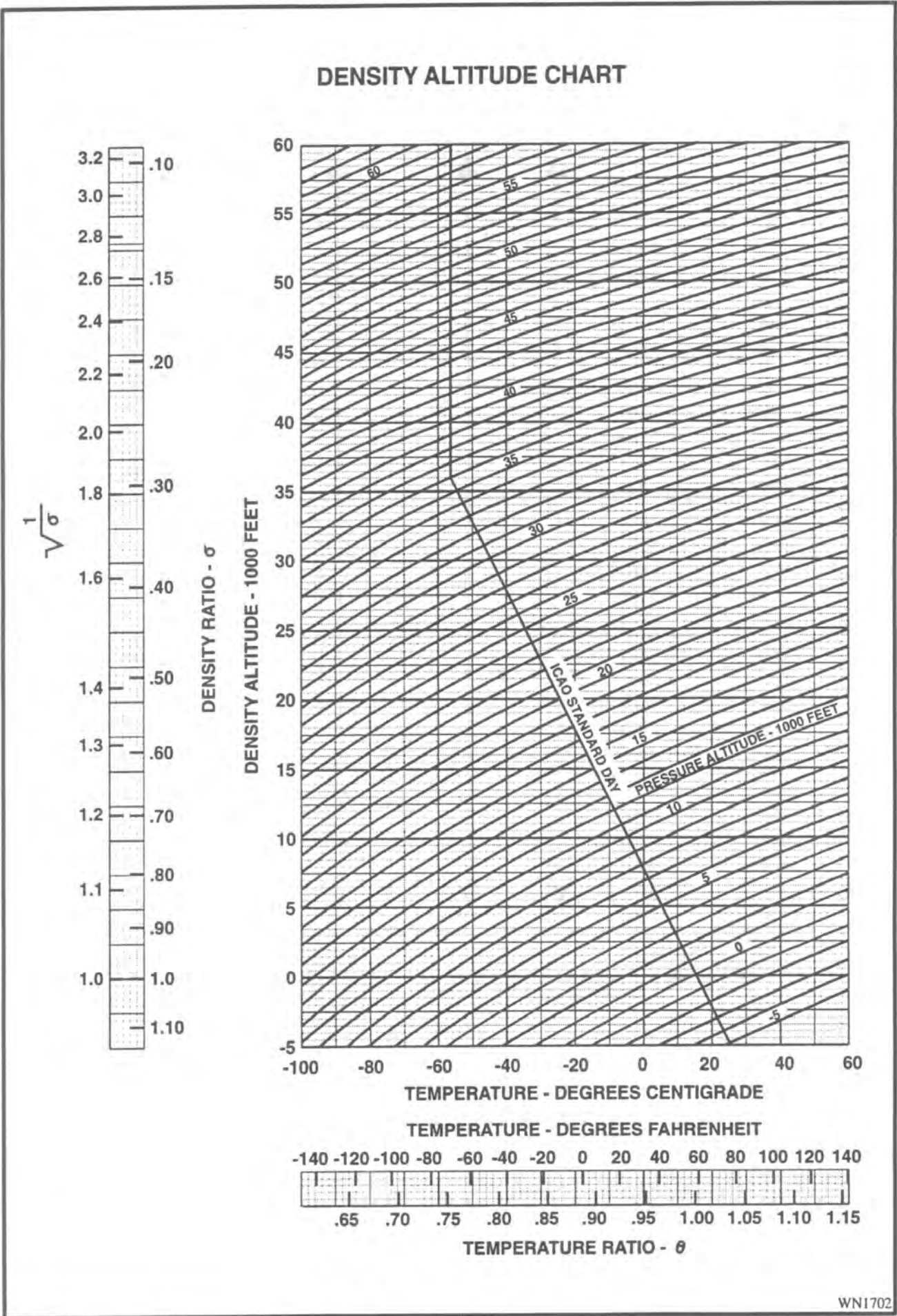
Figure 9-5 Airspeed Conversion

Altitude Feet	Density Ratio $\sigma = \rho/\rho_0$	$\frac{1}{\sqrt{\sigma}}$	Temperature			Speed of Sound Ratio		Pressure
			$^{\circ}\text{C}$	$^{\circ}\text{F}$	Ratio $\theta = T/T_0$	a/a_0	In. of Hg	Ratio $\delta = P/P_0$
Sea Level	1.0000	1.0000	15.000	59.000	1.0000	1.000	29.921	1.0000
1000	0.9711	1.0148	13.019	55.434	0.9931	0.997	28.556	0.9644
2000	0.9428	1.0299	11.038	51.868	0.9862	0.993	27.821	0.9298
3000	0.9151	1.0454	9.056	48.302	0.9794	0.990	26.817	0.8962
4000	0.8881	1.0611	7.075	44.735	0.9725	0.966	25.842	0.8637
5000	0.8617	1.0773	5.094	41.169	0.9656	0.983	24.896	0.8320
6000	0.8359	1.0938	3.113	37.603	0.9587	0.979	23.978	0.8014
7000	0.8106	1.1107	1.132	34.037	0.9519	0.976	23.088	0.7716
8000	0.7860	1.1279	-0.850	30.471	0.9450	0.972	22.225	0.7425
9000	0.7620	1.1756	-2.831	26.905	0.9381	0.969	21.388	0.7148
10,000	0.7385	1.1637	-4.812	23.338	0.9312	0.965	20.577	0.6877
11,000	0.7156	1.1822	-6.793	19.772	0.9244	0.961	19.791	0.6614
12,000	0.6932	1.2011	-8.774	16.206	0.9175	0.958	19.029	0.6360
13,000	0.6713	1.2205	-10.756	12.640	0.9106	0.954	18.292	0.6113
14,000	0.6500	1.2403	-12.737	9.074	0.9037	0.951	17.577	0.5875
15,000	0.6292	1.2606	-14.718	5.508	0.8969	0.947	16.886	0.5643
16,000	0.6090	1.2815	-16.699	1.941	0.8900	0.943	16.216	0.5420
17,000	0.5892	1.3025	-18.680	-1.625	0.8831	0.940	15.569	0.503
18,000	0.5699	1.3246	-20.662	-5.191	0.8762	0.936	14.942	0.4994
19,000	0.5511	1.3470	-22.643	-8.757	0.8694	0.932	14.336	0.4791
20,000	0.5328	1.3700	-24.624	-12.323	0.8625	0.929	13.750	0.4595
21,000	0.5150	1.3935	-26.605	-15.889	0.8556	0.925	13.184	0.4406
22,000	0.4976	1.4176	-28.586	-19.456	0.8487	0.921	12.636	0.4223
23,000	0.4807	1.4424	-30.586	-23.022	0.8419	0.918	12.107	0.4046
24,000	0.4642	1.4678	-32.549	-26.588	0.8350	0.914	11.597	0.3876
25,000	0.4481	1.4938	-34.530	-30.154	0.8281	0.910	11.104	0.3711
26,000	0.4325	1.5206	-36.511	-33.720	0.8212	0.906	10.627	0.3552
27,000	0.4173	1.5480	-38.493	-37.28	0.8144	0.90	10.168	0.3398
28,000	0.4025	1.5762	-40.474	-40.852	0.8075	0.899	9.725	0.3250
29,000	0.3881	1.605	-42.455	-44.419	0.8006	0.895	9.297	0.3107
30,000	0.3741	1.6349	-44.436	-47.985	0.7937	0.891	8.885	0.2970
31,000	0.3605	1.6654	-46.417	-51.551	0.7869	0.887	8.488	0.2837
32,000	0.3473	1.6968	-48.399	-55.117	0.7800	0.883	8.106	0.2709
33,000	0.3345	1.7291	-50.379	-58.683	0.7731	0.879	7.737	0.2586
34,000	0.3220	1.7623	-52.361	-62.219	0.7662	0.875	7.382	0.2467
REMARKS:						(2) ICAO Standard Sea Level Air $t = 15^{\circ}\text{C}$ $P_0 = 29.921$ in. of Hg $p/q - a_0 = 661.8$ knots $\rho_0 = 0.0023769$ slug per cu ft		
(1) One in. of Hg = 70.732 lb per sq ft 0.49121 bper sq in								
DATA BASIS: NACA Technical Note No. 3182								

Figure 9-6 ICAO Standard Altitude Chart (Sheet 1 of 2)

Altitude Feet	Density Ratio $\sigma = \rho/\rho_0$	$\frac{1}{\sqrt{\sigma}}$	Temperature			Speed of Sound Ratio		Pressure
			$^{\circ}\text{C}$	$^{\circ}\text{F}$	Ratio $\theta = T/T_0$	a/a_0	In. of Hg	Ratio $\delta = P/P_0$
35,000	0.3099	1.7964	-54.342	-65.816	0.7594	0.871	7.041	0.2353
36,000	0.2981	1.8315	-56.323	-69.382	0.7525	0.867	6.712	0.2243
36,089	0.2971	1.8347	-56.500	-69.700	0.7519	0.867	6.683	0.2234
37,000	0.2844	1.8753	▲	▲	▲	▲	6.397	0.2138
38,000	0.2710	1.9209					6.097	0.2038
39,000	0.2585	1.9677					5.811	0.1942
40,000	0.2462	2.0155					5.538	0.1851
41,000	0.2346	2.0645					5.278	0.1764
42,000	0.2236	2.1148					5.030	0.1681
43,000	0.2131	2.1662					4.794	0.1602
44,000	0.2031	2.2189					4.569	0.1527
45,000	0.1936	2.2728					4.355	0.1455
46,000	0.1845	2.3281					4.151	0.1387
47,000	0.1758	2.3848					3.956	0.1322
48,000	0.1676	2.4428					3.770	0.1260
49,000	0.1597	2.5022					3.593	0.1201
50,000	0.1522	2.5630					3.425	0.1145
51,000	0.1451	2.6254					3.264	0.1091
52,000	0.1383	2.6892					3.111	0.1040
53,000	0.1318	2.7546					2.965	0.0991
54,000	0.1256	2.8216					2.826	0.0944
55,000	0.1197	2.8903					2.693	0.0900
56,000	0.1141	2.9606					2.567	0.0858
57,000	0.1087	3.0326					2.446	0.0818
58,000	0.1036	3.1063					2.331	0.0779
59,000	0.09877	3.1819					2.222	0.0743
60,000	0.09414	3.2593					2.118	0.0709
61,000	0.08972	3.3386	▼	▼	▼	▼	2.018	0.0675
62,000	0.08551	3.4198					1.924	0.0643
63,000	0.08150	3.5029					1.833	0.0613
64,000	0.07767	3.5881					1.747	0.0584
65,000	0.07403	3.6754	-56.500	-69.700	0.7519	0.867	1.665	0.0557
REMARKS:						(2) ICAO Standard Sea Level Air $t = 15^{\circ}\text{C}$ $P_0 = 29.921$ in. of Hg $p q - a_0 = 661.8$ knots $\rho_0 = 0.0023769$ slug per cu ft		
(1) One in. of Hg = 70.732 lb per sq ft 0.49121 bper sq in								
DATA BASIS: NACA Technical Note No. 3182								

Figure 9-6 ICAO Standard Altitude Chart (Sheet 2 of 2)



WN1702

Figure 9-7 Density Altitude Chart

Degrees Centigrade	Degrees Fahrenheit	Degrees Centigrade	Degrees Fahrenheit	Degrees Centigrade	Degrees Fahrenheit
-75	-103.0	-33	-27.4	9	48.2
-74	-101.2	-33	-25.6	10	50.0
-73	-99.4	-31	-23.8	11	51.8
-72	-97.6	-30	-22.0	12	53.6
-71	-95.8	-29	-20.2	13	55.4
-70	-94.0	-28	-18.4	14	57.2
-69	-92.2	-27	-16.6	15	59.0
-68	-90.4	-26	-14.8	16	60.8
-67	-88.6	-25	-13.0	17	62.6
-66	-86.8	-24	-11.2	18	64.4
-65	-85.0	-23	-9.4	19	66.2
-63	-83.2	-22	-7.6	20	68.0
-63	-81.4	-21	-5.8	21	69.8
-62	-79.6	-20	-4.0	22	71.6
-61	-77.8	-19	-2.2	23	73.4
-60	-76.0	-18	0.4	24	75.2
-59	-74.2	-17	1.4	25	77.0
-58	-72.4	-16	3.2	26	78.8
-57	-70.6	-15	5.0	27	80.6
-56	-68.8	-14	6.8	28	82.4
-55	-67.0	-13	8.6	29	84.2
-53	-65.2	-12	10.4	30	86.0
-53	-63.4	-11	12.2	31	87.8
-52	-61.6	-10	14.0	32	89.6
-51	-59.8	-9	15.8	33	91.4
-50	-58.0	-8	17.6	34	93.2
-49	-56.2	-7	19.4	35	95.0
-48	-54.4	-6	21.2	36	96.8
-47	-52.6	-5	23.0	37	98.6
-46	-50.8	-4	24.8	38	100.4
-35	-49.0	-3	26.6	39	102.2
-34	-47.2	-2	28.4	40	104.0
-43	-45.4	-1	30.2	41	105.8
-42	-43.6	0	32.0	42	107.6
-41	-41.8	1	33.8	43	109.4
-40	-40.0	2	35.6	44	111.2
-39	-38.2	3	37.4	45	113.0
-38	-36.4	4	39.2	46	114.8
-37	-34.6	5	41.0	47	116.6
-36	-32.8	6	42.8	48	118.4
-35	-31.0	7	44.6	49	120.2
-34	-29.2	8	46.4	50	122.0

Figure 9-8 Centigrade / Fahrenheit Conversion

TAKEOFF

Takeoff Charts

9.17 The takeoff charts present takeoff distance, maximum takeoff weight, JATO firing delay, and JATO takeoff distance. The charts encompass such variables as takeoff weight, equivalent airspeed, ambient runway temperature, runway pressure altitude, wind, and runway gradient. Half flaps and MILITARY thrust are recommended for all takeoffs.

9.18 Variables, which are not considered in the charts, that will influence the acceleration of the aircraft during ground run are pilot braking to maintain directional control; runway surface conditions which constitute a lower or higher value for the rolling coefficient of friction (μ); external store loadings on the wing stations which protrude forward or near the leading edge of the wing and influence the flow field of air over the wing, reducing lift and increasing required takeoff speeds; and rough or bumpy runways which influence the taxi attitude of the aircraft, introducing aerodynamic braking during the ground run. Of these variables, pilot braking, which is a function of pilot technique, probably has the greatest influence on acceleration-retardation and will increase the ground run significantly.

Operational Takeoff Distance

9.19 Operational takeoff distance, total distance to clear a 50-foot obstacle, without JATO assist, and recommended takeoff speeds are shown in Figure 9-13 and Figure 9-15. Takeoff distances are based on half flaps, MILITARY thrust, and 8 degrees aircraft noseup trim.

9.20 The A-4 takeoff airspeeds and distances are based on NATC flight test data of the Model A-4E aircraft. Note the region in the altitude correction box where MAXIMUM TAKEOFF WEIGHT MAY BE EXCEEDED. This region represents an area in which the minimum acceptable thrust-to-weight ratio may be encountered, resulting in marginal climbout capability, or the safe tire limit speed of 175 knots ground speed may be exceeded. Since temperature, altitude, and wind are not independent, the boundary lines in this box are shown for extreme altitude-temperature wind combinations. A more detailed explanation of the marginal wind region is given

under maximum takeoff weight. The method of obtaining the ground run distance, total distance to clear a 50-foot obstacle, and takeoff airspeed, and the line speed check are described in the following example.

NOTE

If operational conditions require takeoffs for which computed takeoff distance places the aircraft in the region labelled TAKEOFF IS MARGINAL on the chart, lift-off speed should be increased approximately 5 to 10 knots, not to exceed tire limiting speed. This will result in increased rates of climb. Runway length and location of abort gear must be considered in planning this type of takeoff.

SAMPLE PROBLEM

Takeoff Distance – Operational

(For Figure 9-13)

- (A) Takeoff weight 20,000 pounds
- (B) Takeoff airspeed 146 KEAS
- (C) Ambient runway air temperature 30°C
- (D) Runway pressure altitude 2000 feet
- (E) Headwind 10 knots
- (F) Runway gradient - 2 percent
- (G) Ground run distance 3150 feet
- (H) Total distance to clear
50-foot obstacle 4500 feet

9.21 Observe that step (D) fell within the area labelled MAXIMUM TAKEOFF WEIGHT MAY BE EXCEEDED. To determine if this takeoff weight does exceed the maximum takeoff weight refer to Figure 9-14 at the given temperature, pressure altitude, and wind conditions. For this problem the maximum takeoff weight is 24,500 pounds. Since the actual weight, 20,000 pounds, is less than maximum this takeoff may be safely completed.

LINE SPEED CHECK

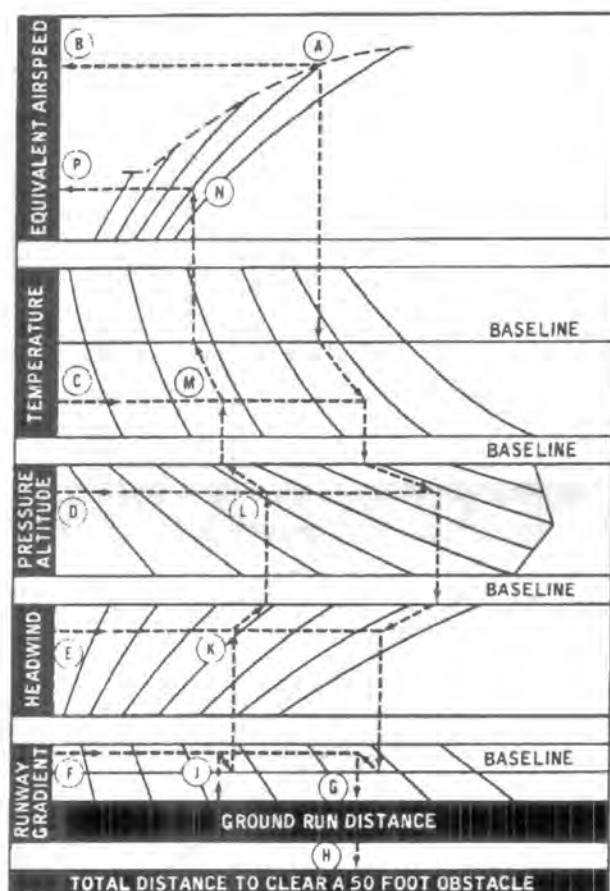


Figure 9-9 Sample Takeoff Distance

9.22 A line speed check is a simple procedure for determining that aircraft acceleration during takeoff is normal, sufficiently early in the takeoff run to allow normal braking to stop the aircraft on the runway. The pilot selects a suitable and recognizable known distance down the runway from the point that takeoff run commences (such as runway distance marker, runway intersection, etc). The normal takeoff distance chart is used by entering the chart at the selected distance and working in reverse through the chart, applying the corrections for variation from standard conditions.

- (J) Runway gradient -2 percent
- (K) Headwind 10 knots
- (L) Runway pressure altitude 2000 feet
- (M) Ambient runway air temperature 30°C
- (N) Takeoff weight 20,000 pounds
- (O) Equivalent airspeed 119 KEAS

MAXIMUM TAKEOFF WEIGHT

9.23 The maximum takeoff weight (Figure 9-14 and Figure 9-16) is given as a function of ambient air temperature, pressure altitude and wind condition. The data basis for these charts assumes that the landing gear is fully extended, takeoff is at airspeeds shown on the takeoff distance charts, the aircraft is climbing out with MILITARY thrust with the assist of ground effect, multiple carriage stores are carried on wing stations, and the wing flaps are set at the half-flap position.

9.24 The maximum takeoff weight criteria is based on the most critical of the following:

1. Excess thrust shall not be less than minimum established by NATC flight test.
2. The safe tire speed limit of 175 knots ground speed shall not be exceeded.
3. Takeoff weight limit of 24,500 pounds.

9.25 The above criteria, when met, will provide acceptable climbout characteristics.

9.26 To use these charts it is required that a maximum takeoff weight be determined for each of the above criteria. The limiting weight will then be the lightest of the three.

SAMPLE PROBLEM

Maximum Takeoff Weight

(For Figure 9-14)

- (A) Ambient runway air temperature 40°C
- (B) Runway pressure altitude 6000 ft
- (C) Zero wind baseline
- (D) Maximum tailwind allowable for takeoff at weights below which liftoff speed is constant (under 17,000 pounds) 18 knots (tailwind)
- (E) Wind velocity 10 knots (headwind)
- (F) Maximum takeoff weight (limited by safe tire speed) ... 23,300 pounds
- (G) Ambient runway air temperature 40°C
- (H) Runway pressure altitude 6000 ft
- (I) Maximum takeoff weight (limited by minimum excess thrust) 22,100 pounds

9.27 Since the maximum takeoff weight is determined by the most critical of the above criteria, the maximum takeoff weight for this example is 22,100 pounds (limited by minimum excess thrust).

9.28 Observe that if there had been zero wind, the maximum takeoff weight would have been 21,100 pounds (limited by safe tire speed).

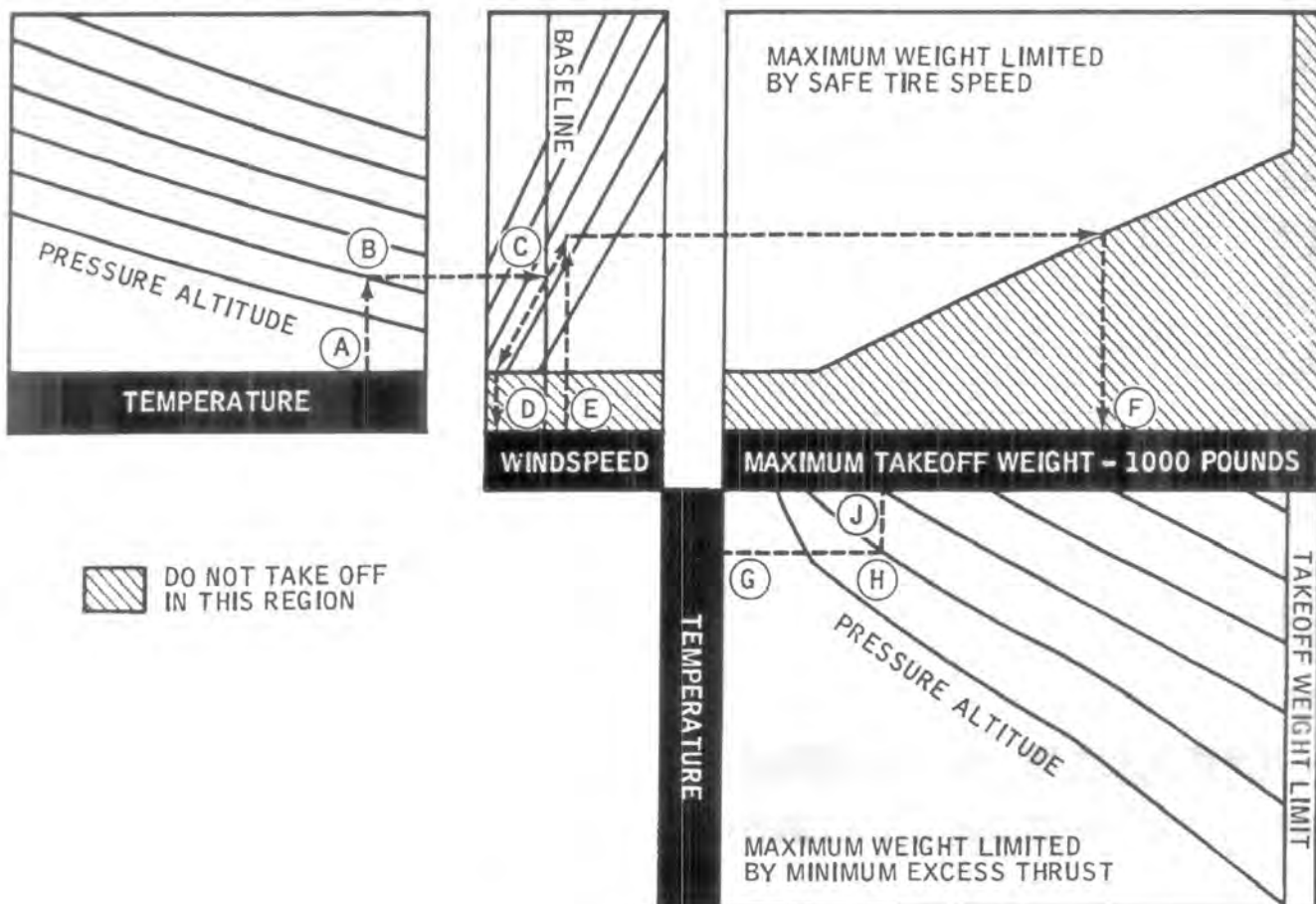


Figure 9-10 Sample Maximum Takeoff Weight

Refusal Speed

9.29 The maximum refusal speed is that speed at which engine failure permits stopping the aircraft on a runway of specified length. Figure 9-17 and Figure 9-18 present this data for engine failure during a military thrust takeoff. Data includes distance covered during a pilot reaction time of 2 seconds and for an 8-second engine deceleration time from military to idle rpm.

NOTE

Figure 9-17 and Figure 9-18 take no account of use of drag chute.

SAMPLE PROBLEM

Takeoff Refusal Speeds

(For Figure 9-17)

Configuration: All configurations

- (A) Runway temperature 20°C
- (B) Runway pressure altitude 2000 ft
- (C) Transfer scale 0.95
- (D) Field length 8000 ft
- (E) Takeoff weight 18,000 lb
- (F) Headwind 10 Kts
- (G) Runway gradient -1 percent
- (H) Takeoff refusal speed
(Spoilers open) 98 KIAS

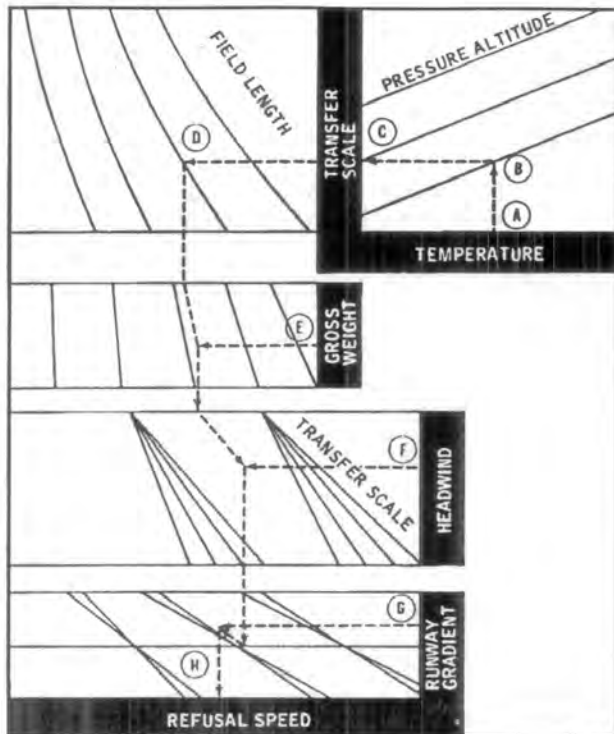


Figure 9-11 Sample Takeoff Refusal Speed

Stopping Distance

9.30 The stopping distance charts (Figure 9-19 and Figure 9-20) are included primarily for use if the takeoff should be aborted. It is not intended for use in determining landing distance. The data does not include pilot reaction and deceleration time. Distances are based on the application of maximum braking effort without skidding the tires, below brake energy limit speed, and throttle positioned at idle thrust. To minimize diversion of pilot's attention during this critical stage of the takeoff abort, it is recommended that flaps be left in the position selected for takeoff.

NOTE

Shutting down the engine at 80 KIAS will shorten the rollout considerably.

Figure 9-19 and Figure 9-20 take no account of use of drag chute.

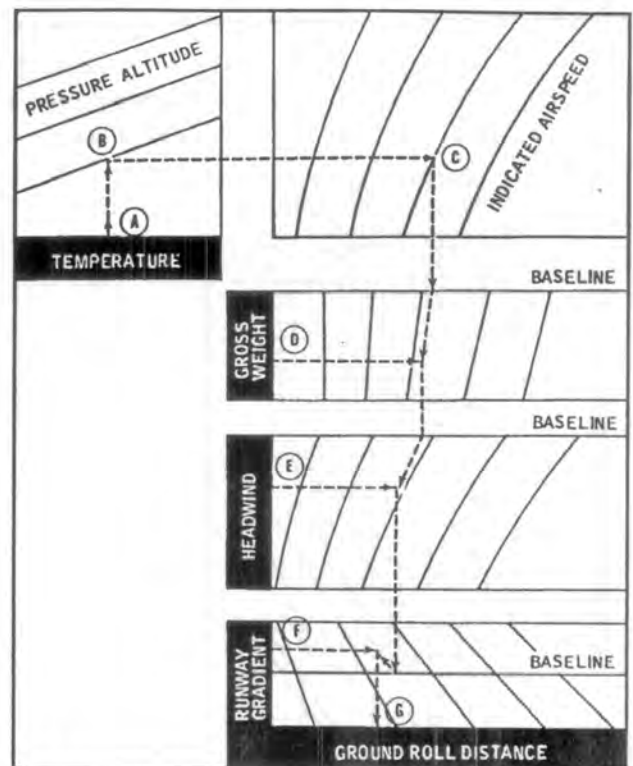


Figure 9-12 Sample Stopping Distance

SAMPLE PROBLEM

Stopping Distance

(For Figure 9-19)

Configuration: All Configurations

- (A) Runway temperature 20°C
- (B) Runway pressure altitude 2000 ft
- (C) Indicated airspeed at abort
(Spoilers open) 98 KIAS
- (D) Aircraft gross weight 18,000 lb
- (E) Headwind 10 Kts
- (F) Runway gradient - 1 percent
- (G) Stopping distance
(Spoilers open) 4200 ft

AL 7(0)

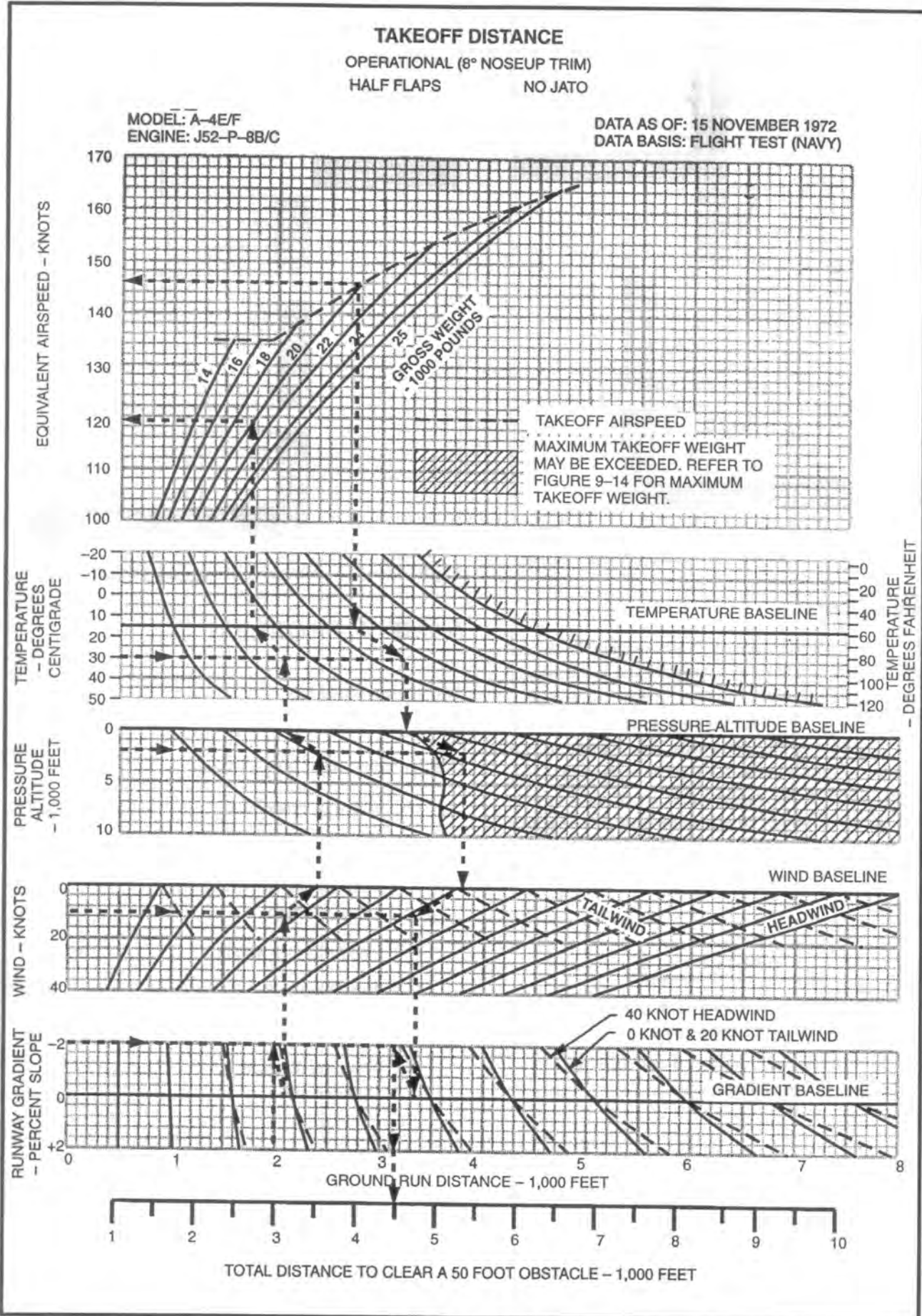


Figure 9-13 Takeoff Distance A-4

AL 7(0)

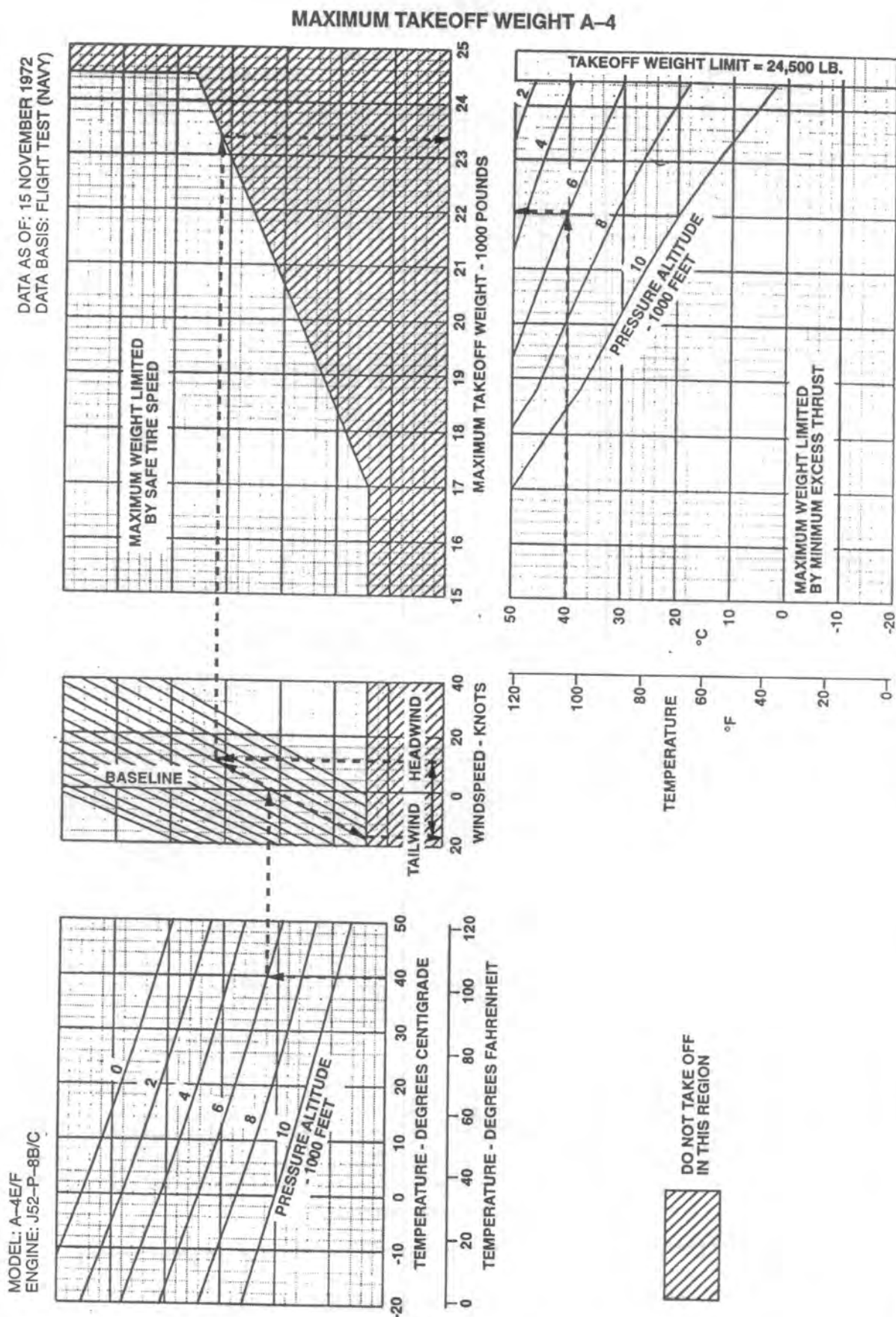


Figure 9-14 Maximum Takeoff Weight A-4

TAKEOFF DISTANCE **OPERATIONAL (8° NOSE UP TRIM)** **HALF FLAPS NO JATO**

MODEL: TA-4F
 ENGINE: J52-P-8B/C

DATA AS OF : 1 MAY 1972
 DATA BASIS: FLIGHT TEST (NAVY)

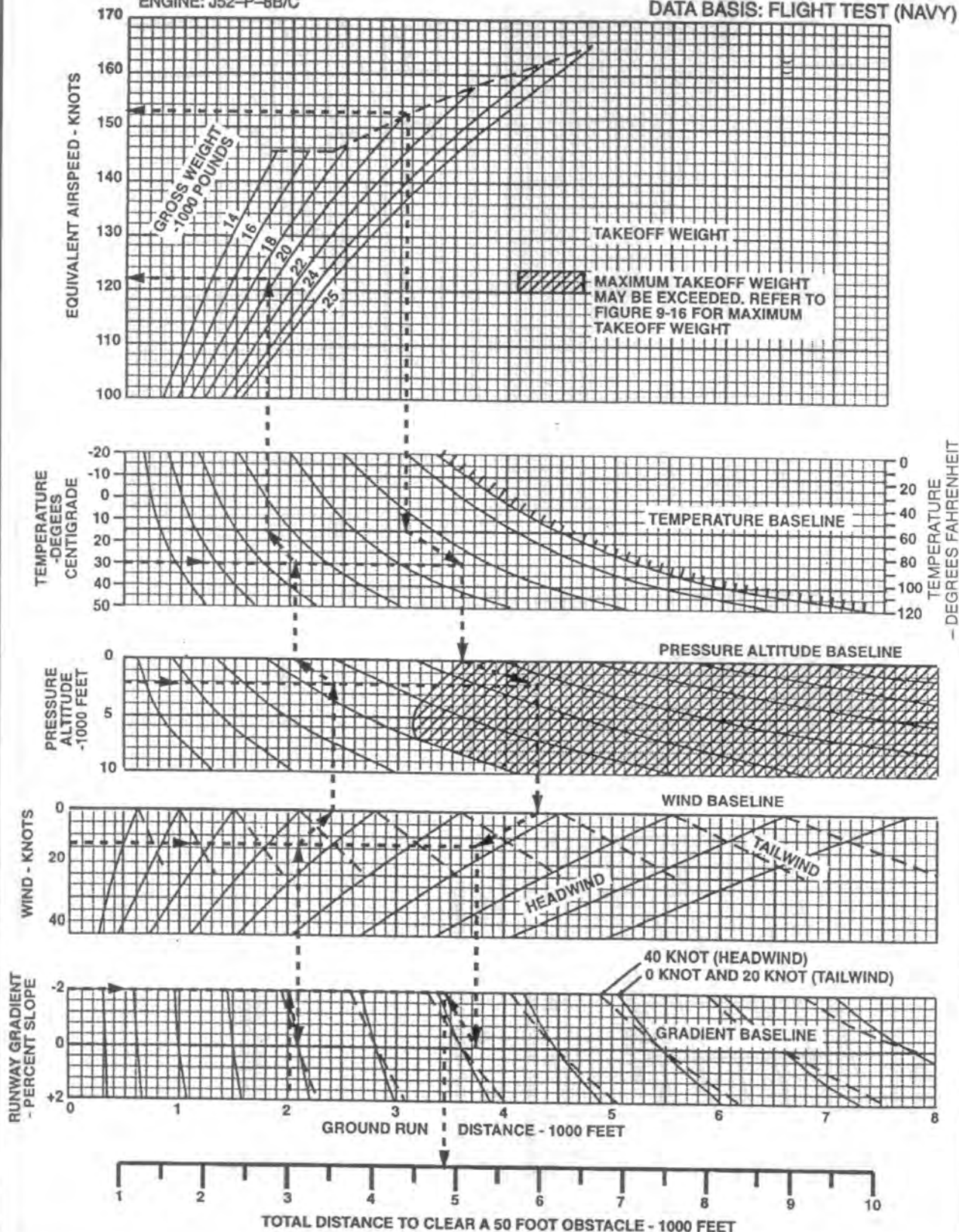
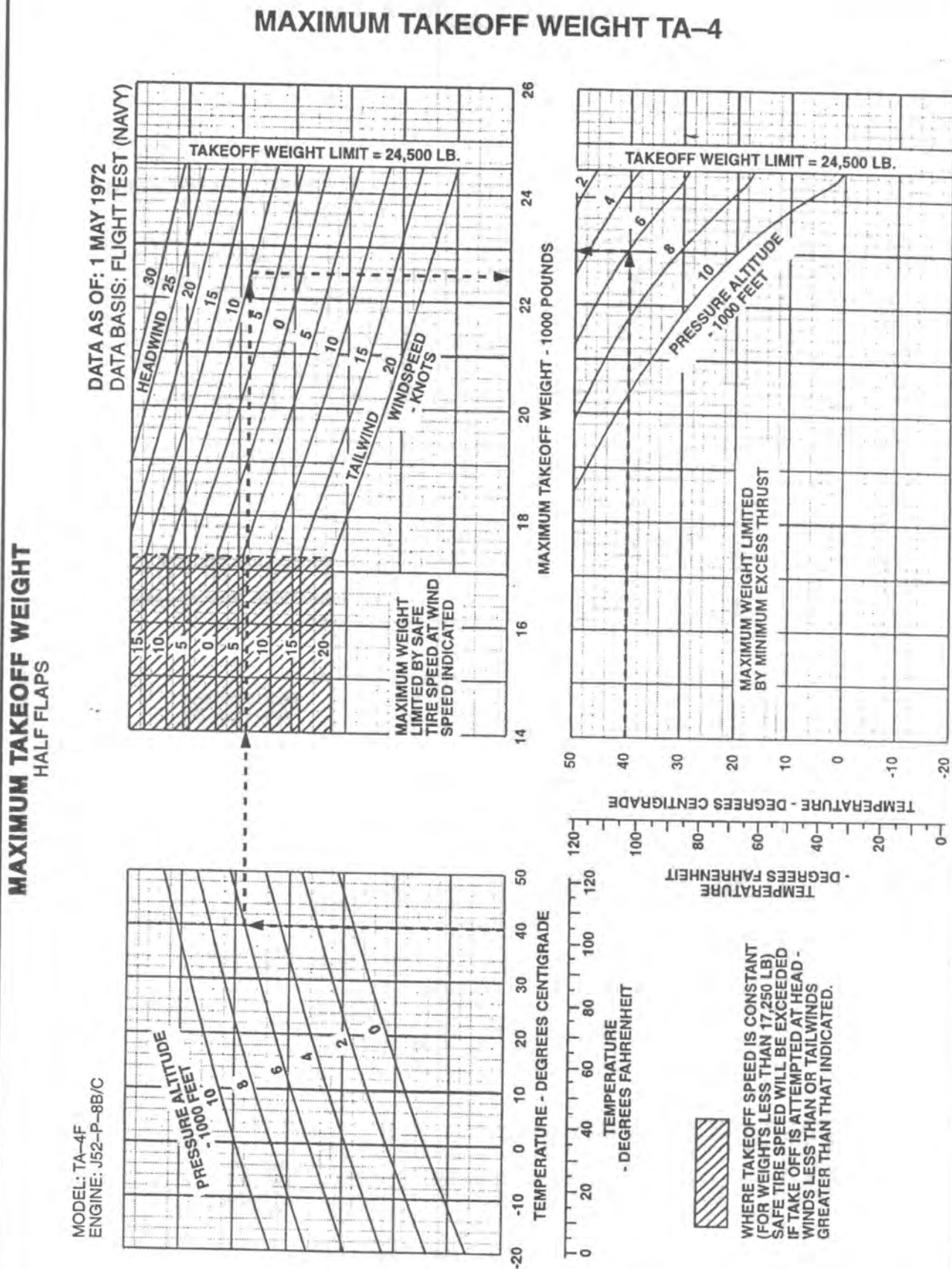


Figure 9-15 Takeoff Distance TA-4



TAKEOFF REFUSAL SPEED SPEEDBRAKES AND SPOILERS OPEN HALF FLAPS

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: ESTIMATED

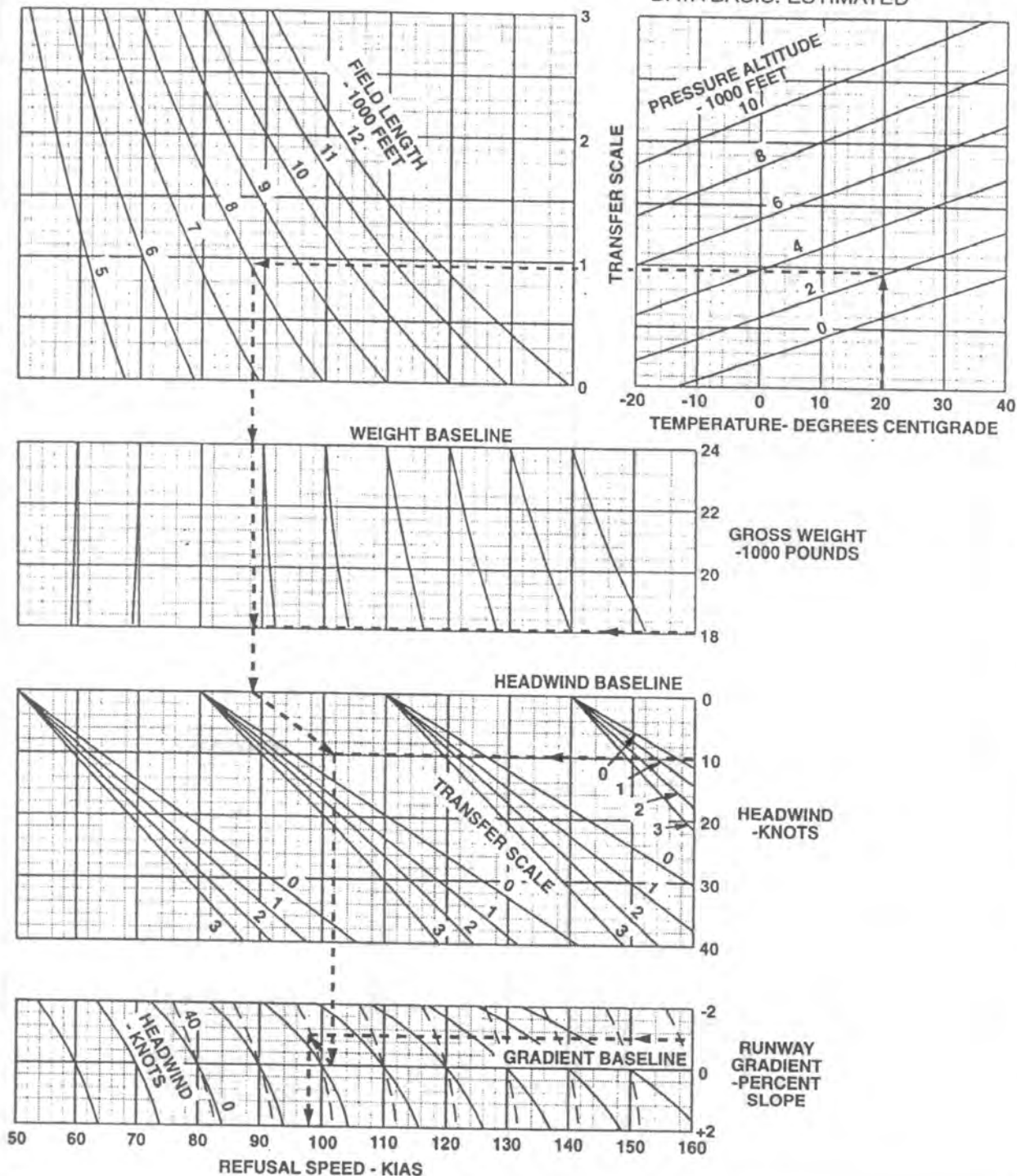


Figure 9-17 Takeoff Refusal Speeds A-4

AL 7(0)

TAKEOFF REFUSAL SPEED **SPEEDBRAKES AND SPOILERS OPEN** **HALF FLAPS**

MODEL: TA-4F
 ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
 DATA BASIS: ESTIMATED

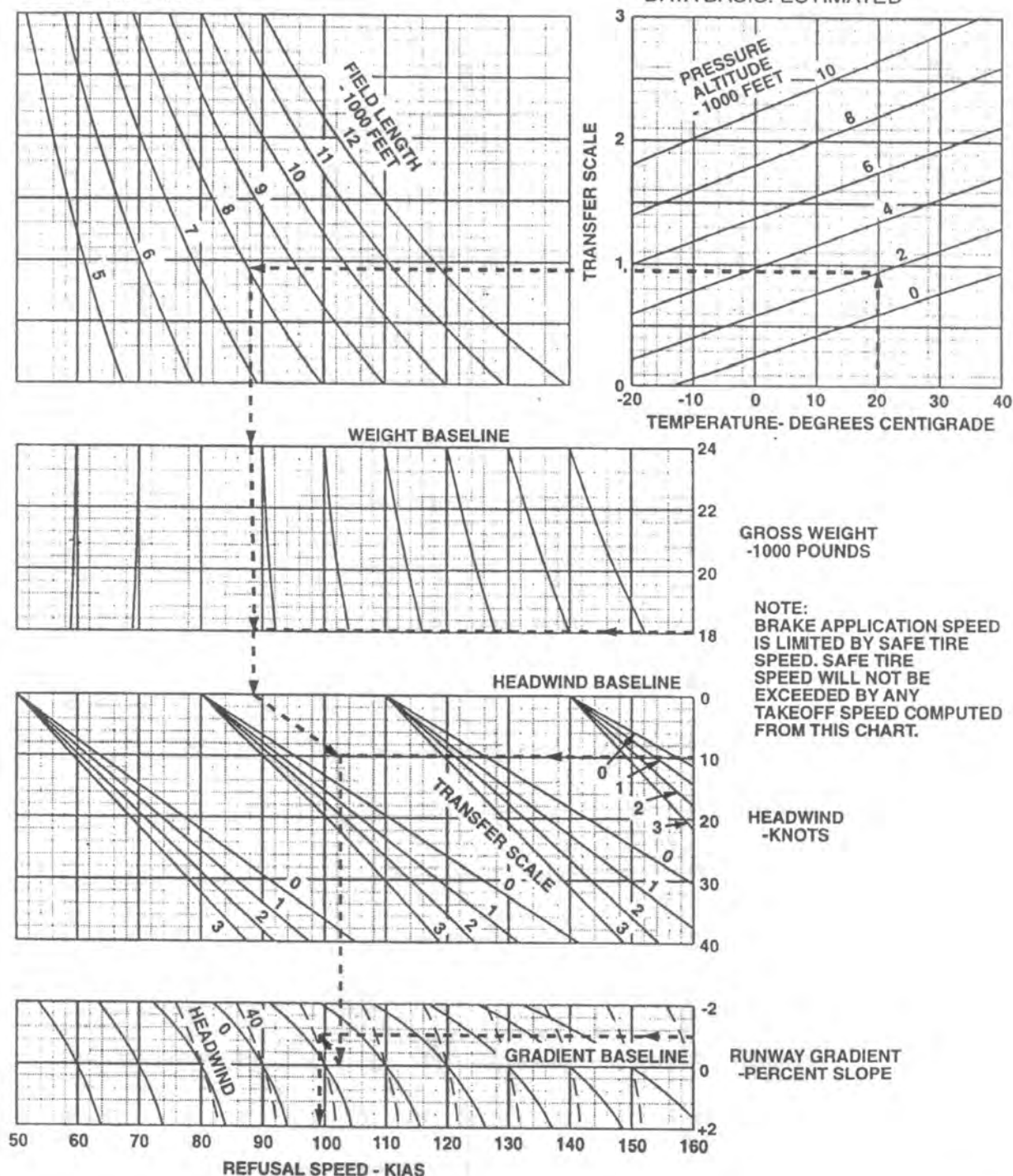


Figure 9-18 Takeoff Refusal Speeds TA-4

STOPPING DISTANCE **SPEEDBRAKES AND SPOILERS OPEN** **HALF FLAPS**

MODEL: A-4E/F
 ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
 DATA BASIS: ESTIMATED

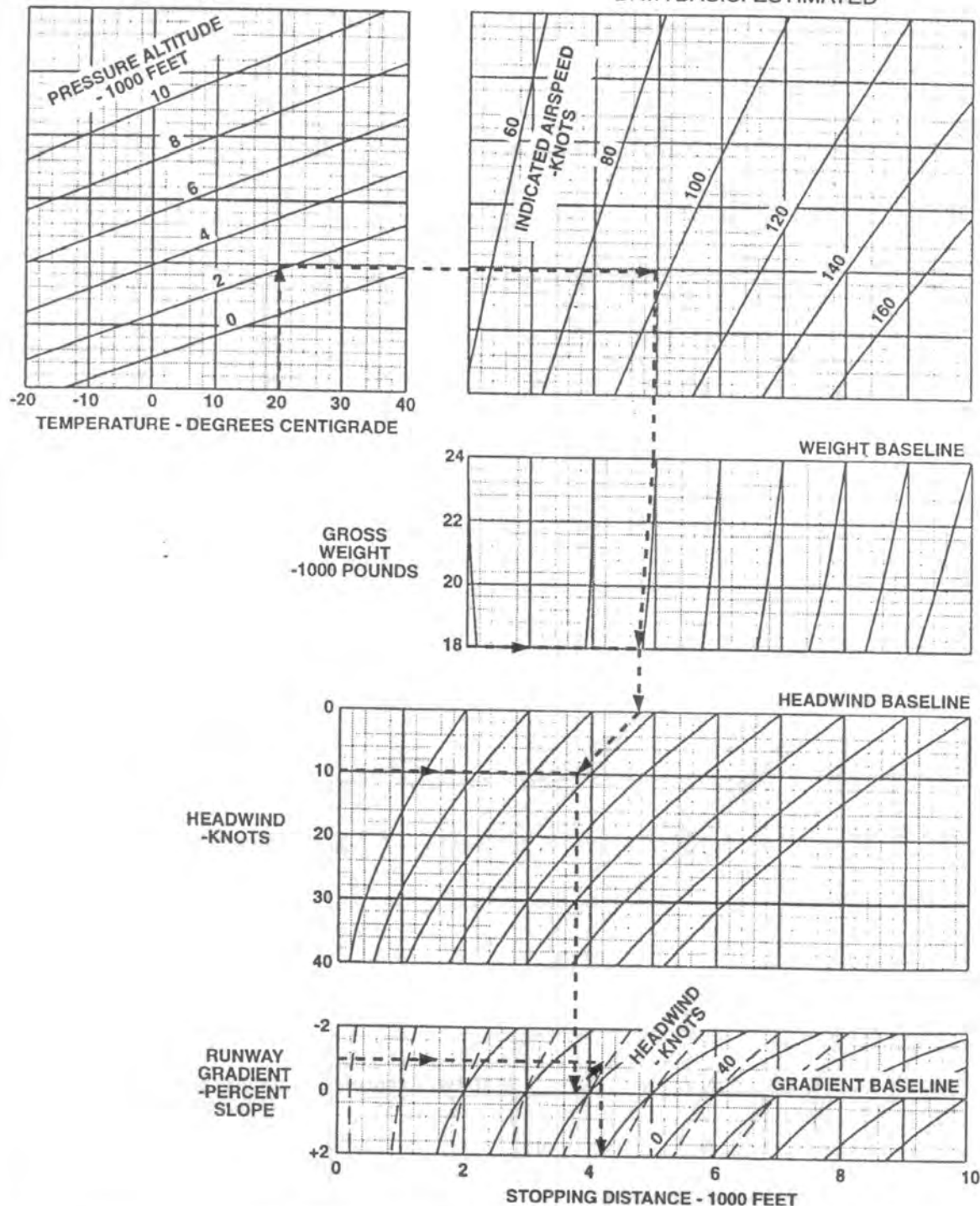


Figure 9-19 Stopping Distance A-4

AL 7(0)

STOPPING DISTANCE SPEEDBRAKES AND SPOILERS OPEN HALF FLAPS

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: ESTIMATED

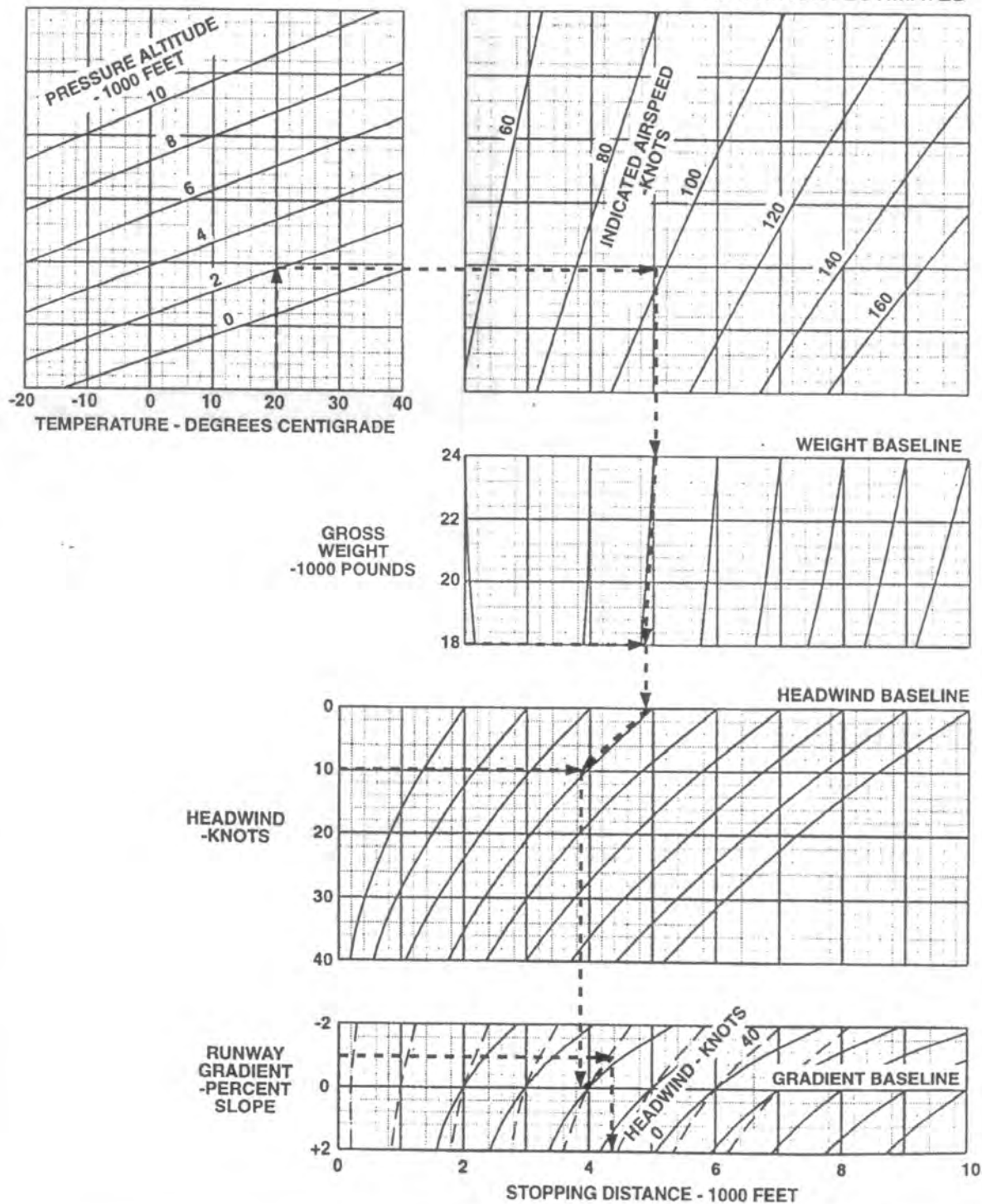


Figure 9-20 Stopping Distance TA-4

CLIMB

CLIMB

9.31 Climb charts (Figure 9-24 through Figure 9-32) present the climb performance for all drag index configurations with the engine operating at military thrust. Climb speeds are presented in Figure 9-24, and Figure 9-25, as a function of drag index but independent of gross weight. The climb speed schedule is based on a minimum time to climb and does not represent a maximum range climb.

9.32 Fuel, distance, and time to climb are presented in Figure 9-26 through Figure 9-31 as a function of gross weight, pressure altitude, drag index, and temperature deviation from ICAO standard day. The data are based on the climb speed schedule.

SAMPLE PROBLEM

Climb Speed Schedule

(For Figure 9-24)

- (A) Cruise altitude 30,000 ft
- (B) Drag index 50
- (C) Climb speed at cruise altitude 276 KCAS
- (D) Initial climb altitude 5000 ft
- (E) Climb speed at initial altitude 337 KCAS

SAMPLE PROBLEM

Climb Fuel

9.33 The method of presenting data for fuel, distance, and time is identical; therefore, only one sample is shown. (For Figure 9-26)

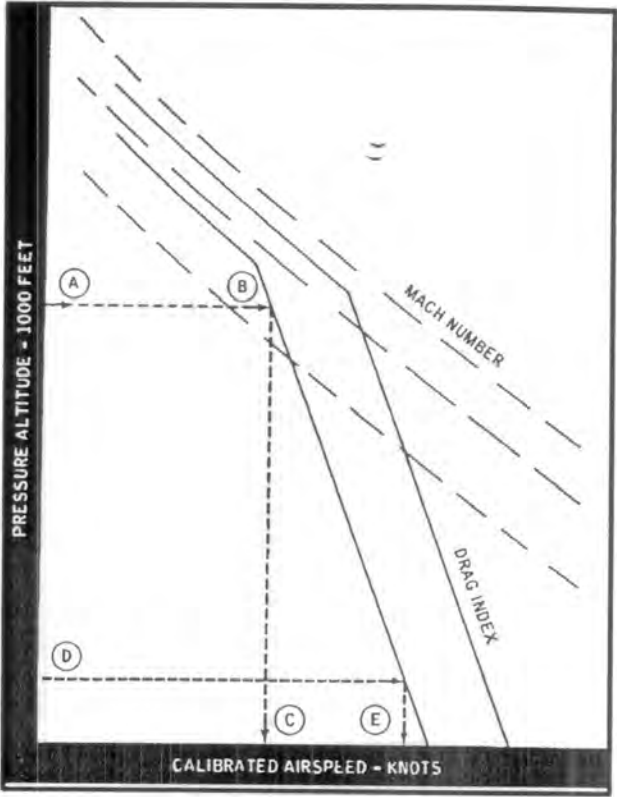


Figure 9-21 Sample Climb Speed Schedule

- (A) Initial gross weight 18,000 lb
- (B) Cruise altitude 30,000 ft
- (C) Drag index 50
- (D) Temperature baseline
- (E) Temperature deviation from ICAO Standard day +10°C
- (F) Fuel to climb from sea level 560 lb

COMBAT CEILING AND OPTIMUM CRUISE ALTITUDE

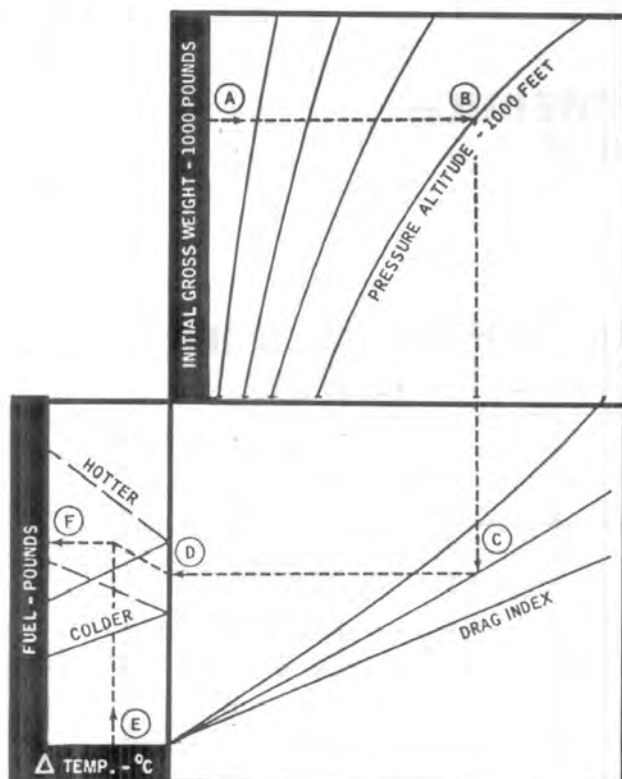


Figure 9-22 Sample Climb Fuel

9.34 Combat ceiling, the altitude for 500-fpm rate of climb with military thrust, and optimum cruise altitude, the altitude that will produce the maximum cruise distance per pound of fuel, are presented in Figure 9-32 and Figure 9-33. The data are presented as a function of gross weight and drag index.

SAMPLE PROBLEM

(For Figure 9-32)

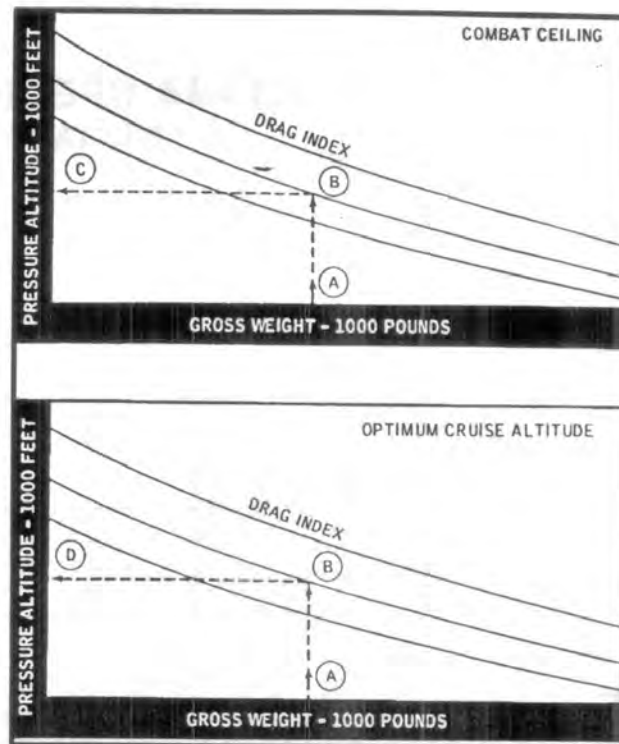


Figure 9-23 Sample Combat Ceiling and Optimum Cruise Altitude

- (A) Aircraft gross weight 18,000 lb
(B) Drag index 50
(C) Combat ceiling 37,900 ft
(D) Optimum cruise altitude 31,100 ft

CLIMB SPEED SCHEDULE MILITARY THRUST

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST

MODEL: A-4E/F
ENGINE: J52-P-8B/C

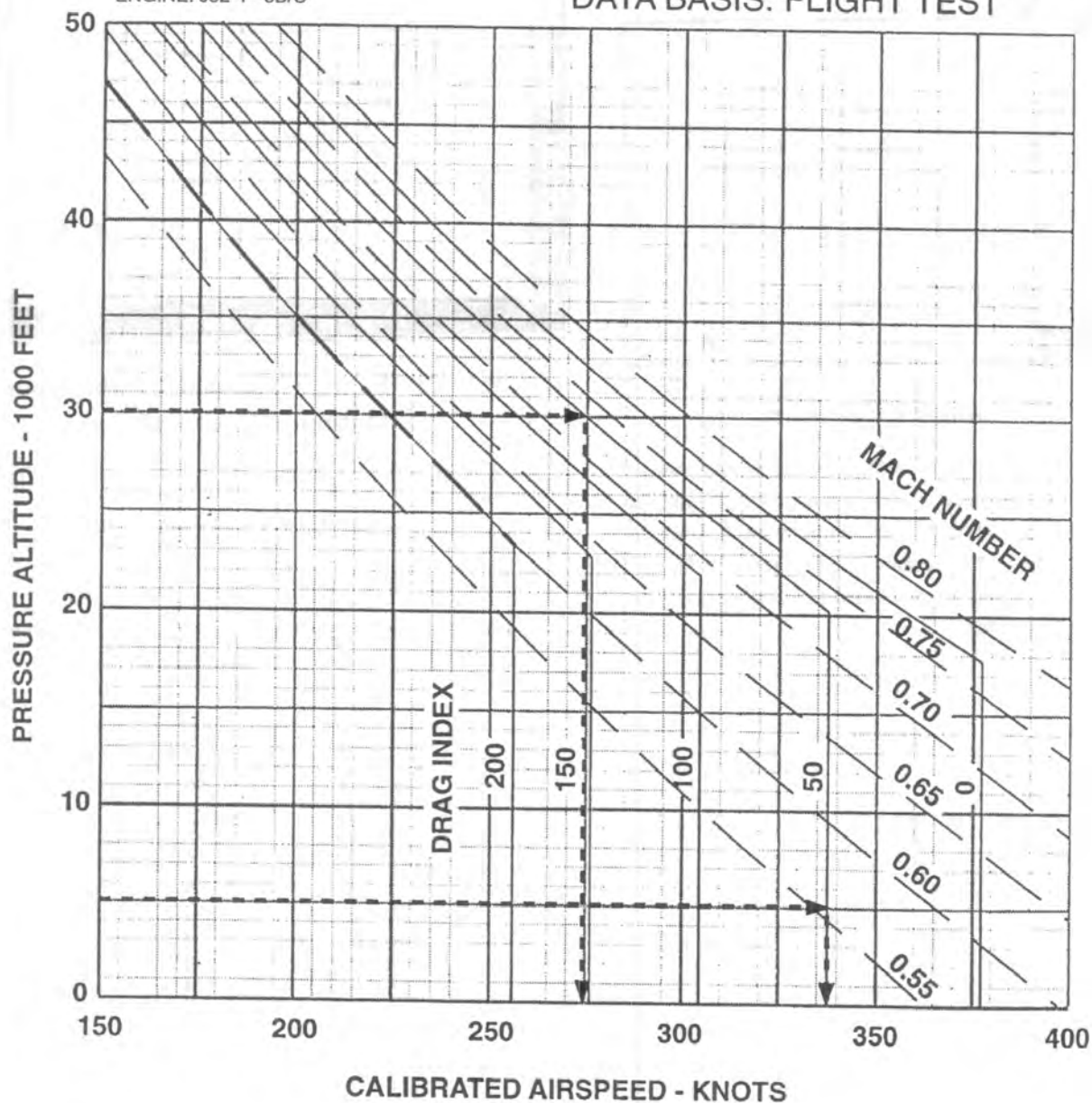


Figure 9-24 Climb Speed Schedule A-4

AL 7(0)

CLIMB SPEED SCHEDULE MILITARY THRUST

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

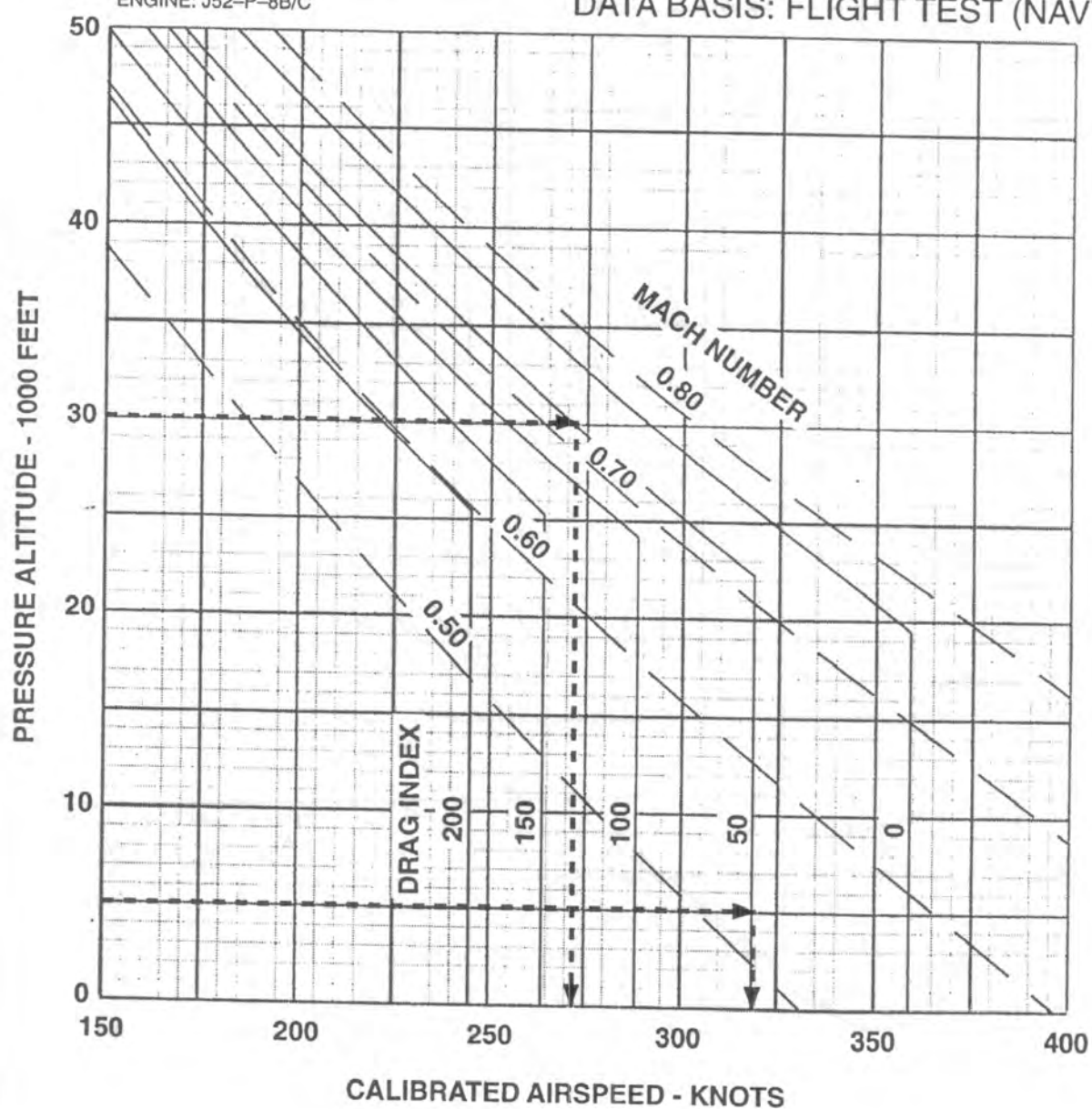


Figure 9-25 Climb Speed Schedule TA-4

MILITARY THRUST CLIMB FUEL USED

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)

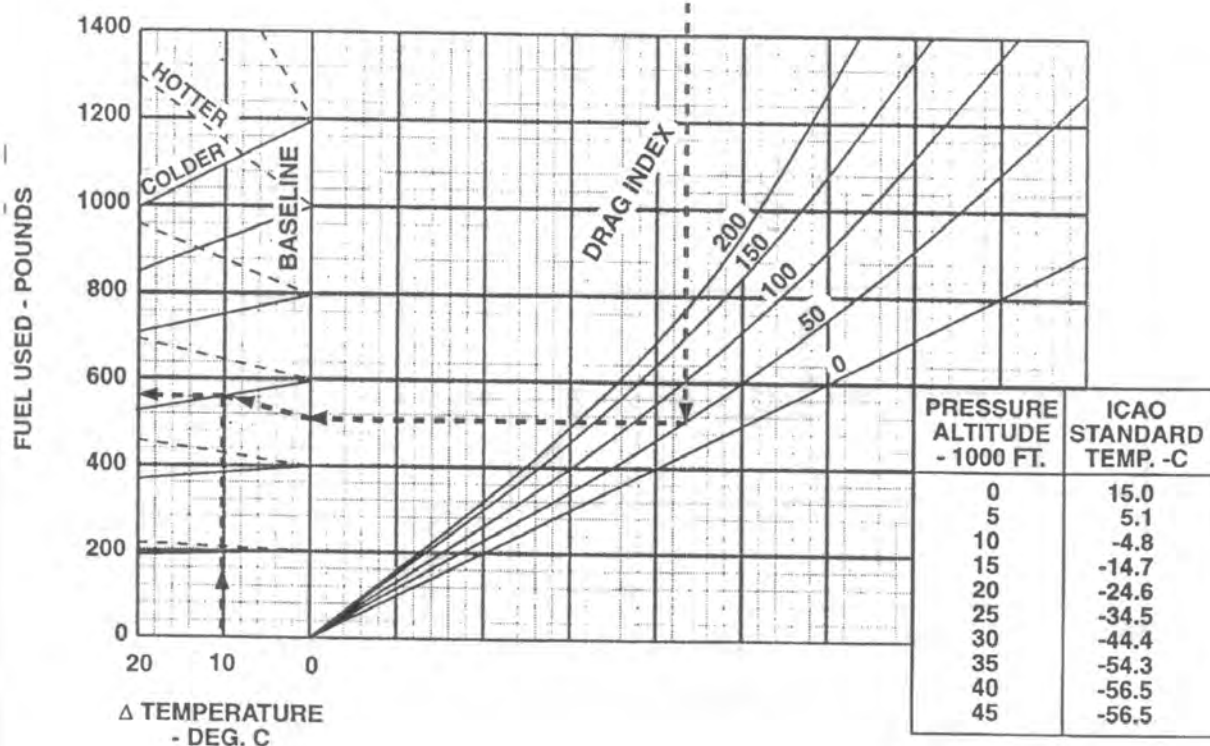
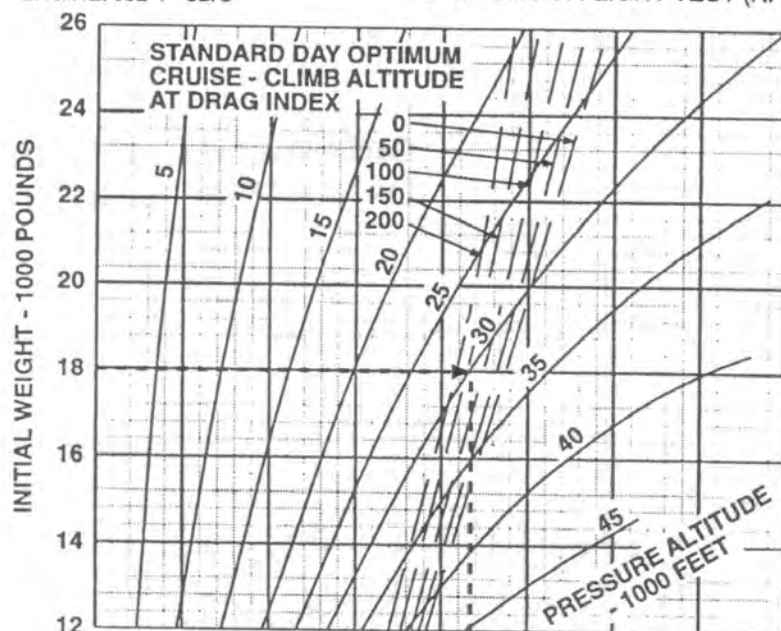


Figure 9-26 Climb Fuel A-4

AL 7(0)

MILITARY THRUST CLIMB FUEL USED

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

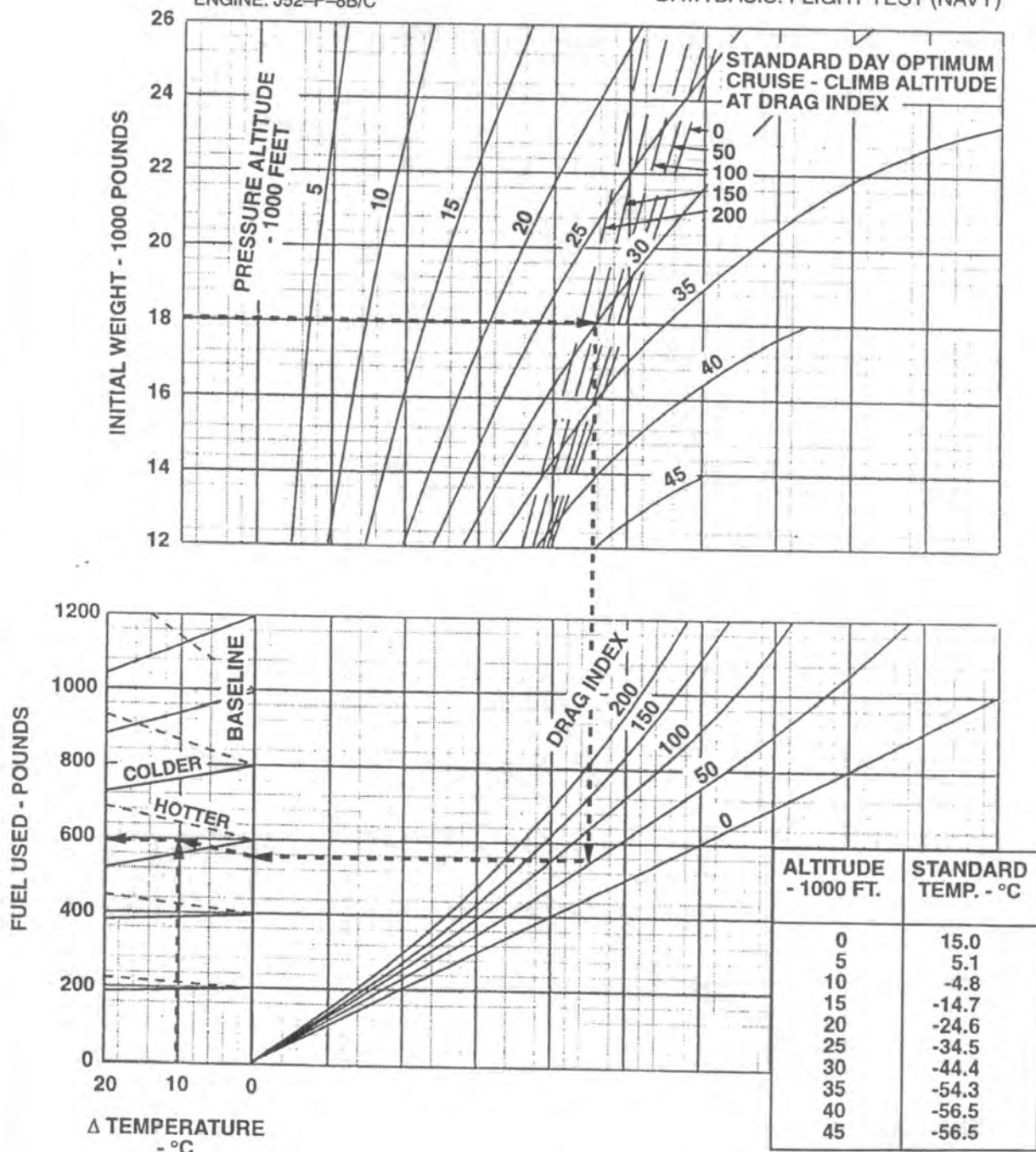
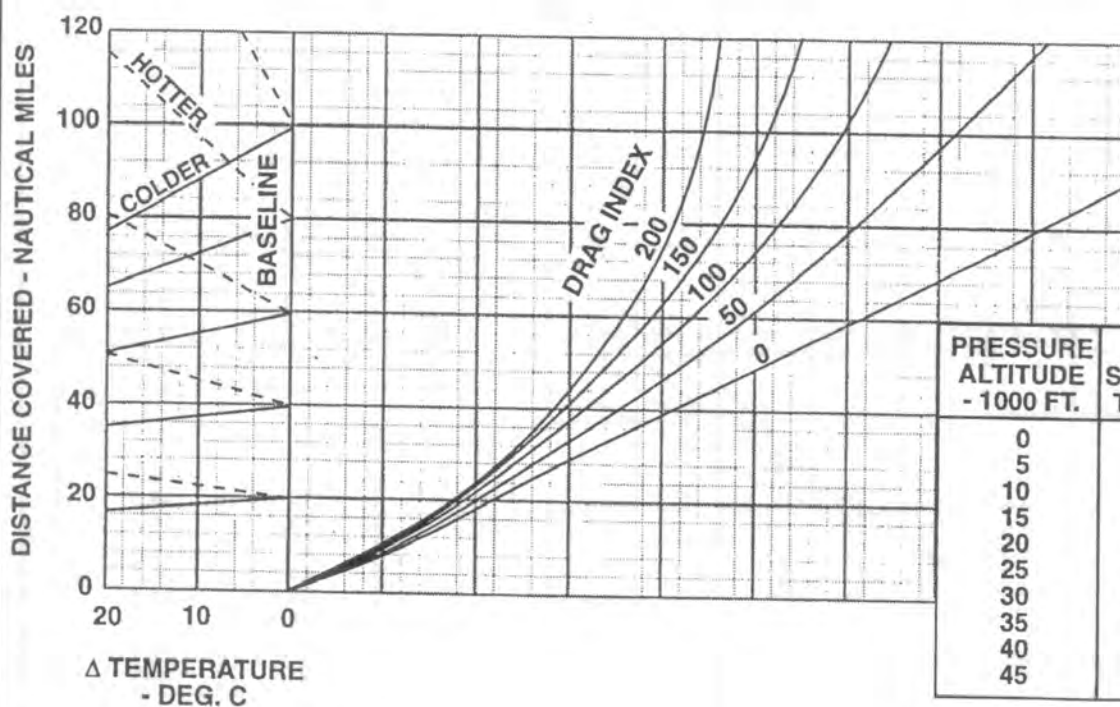
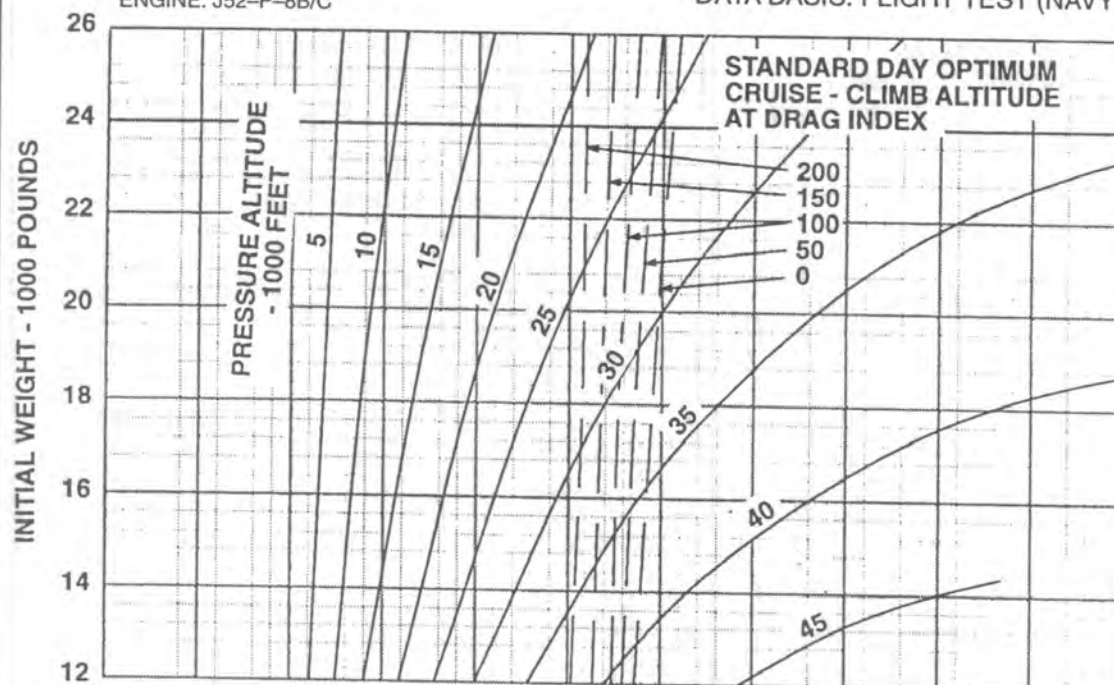


Figure 9-27 Climb Fuel TA-4

MILITARY THRUST CLIMB DISTANCE COVERED

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)



PRESSURE ALTITUDE - 1000 FT.	ICAO STANDARD TEMP. - °C
0	15.0
5	5.1
10	-4.8
15	-14.7
20	-24.6
25	-34.5
30	-44.4
35	-54.3
40	-56.5
45	-56.5

Figure 9-28 Climb Distance A-4

AL 7(0)

MILITARY THRUST CLIMB DISTANCE COVERED

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

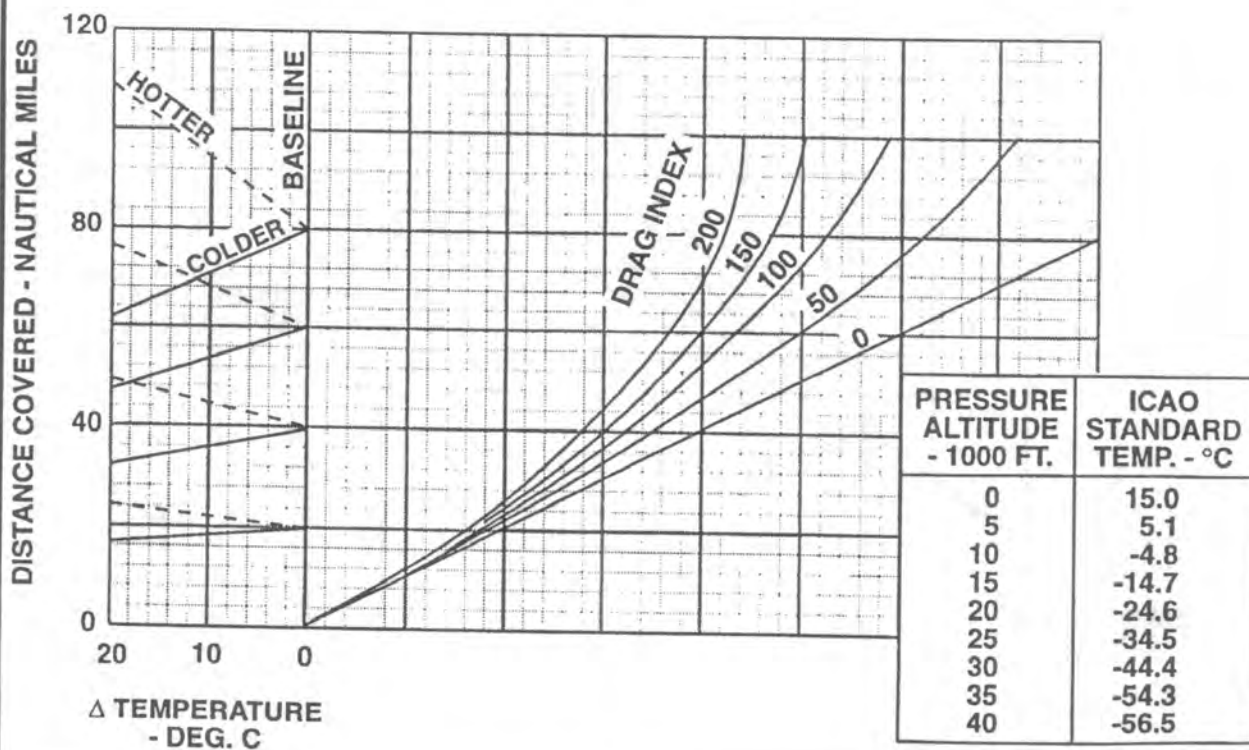
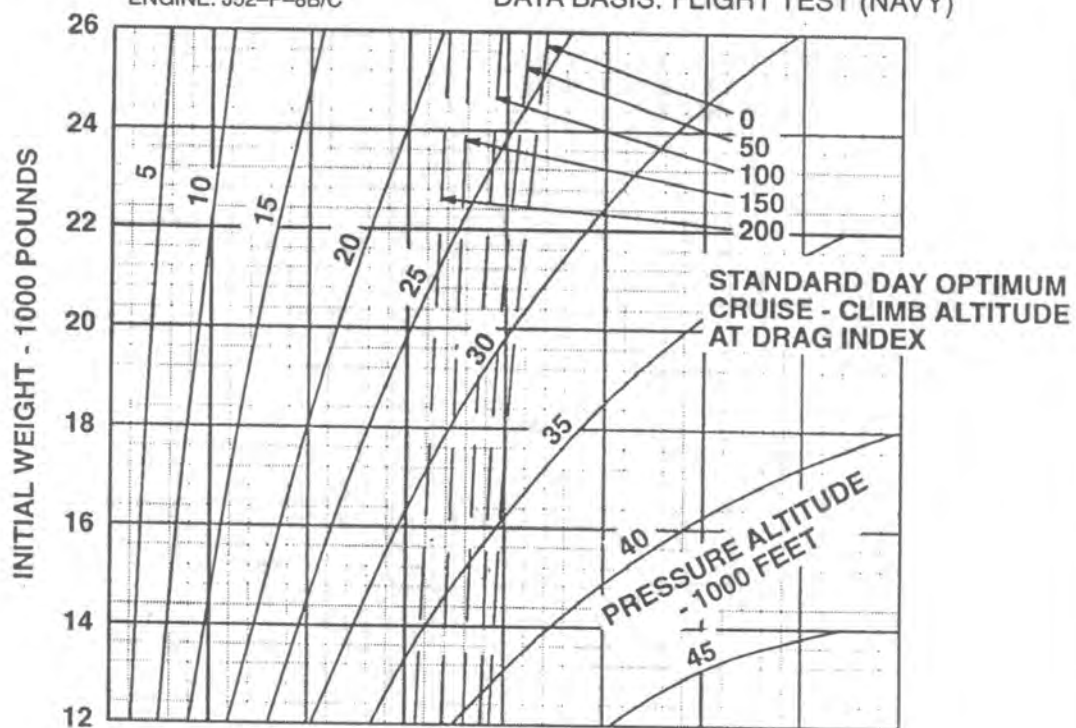


Figure 9-29 Climb Distance TA-4

MILITARY THRUST CLIMB TIME TO CLIMB

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)

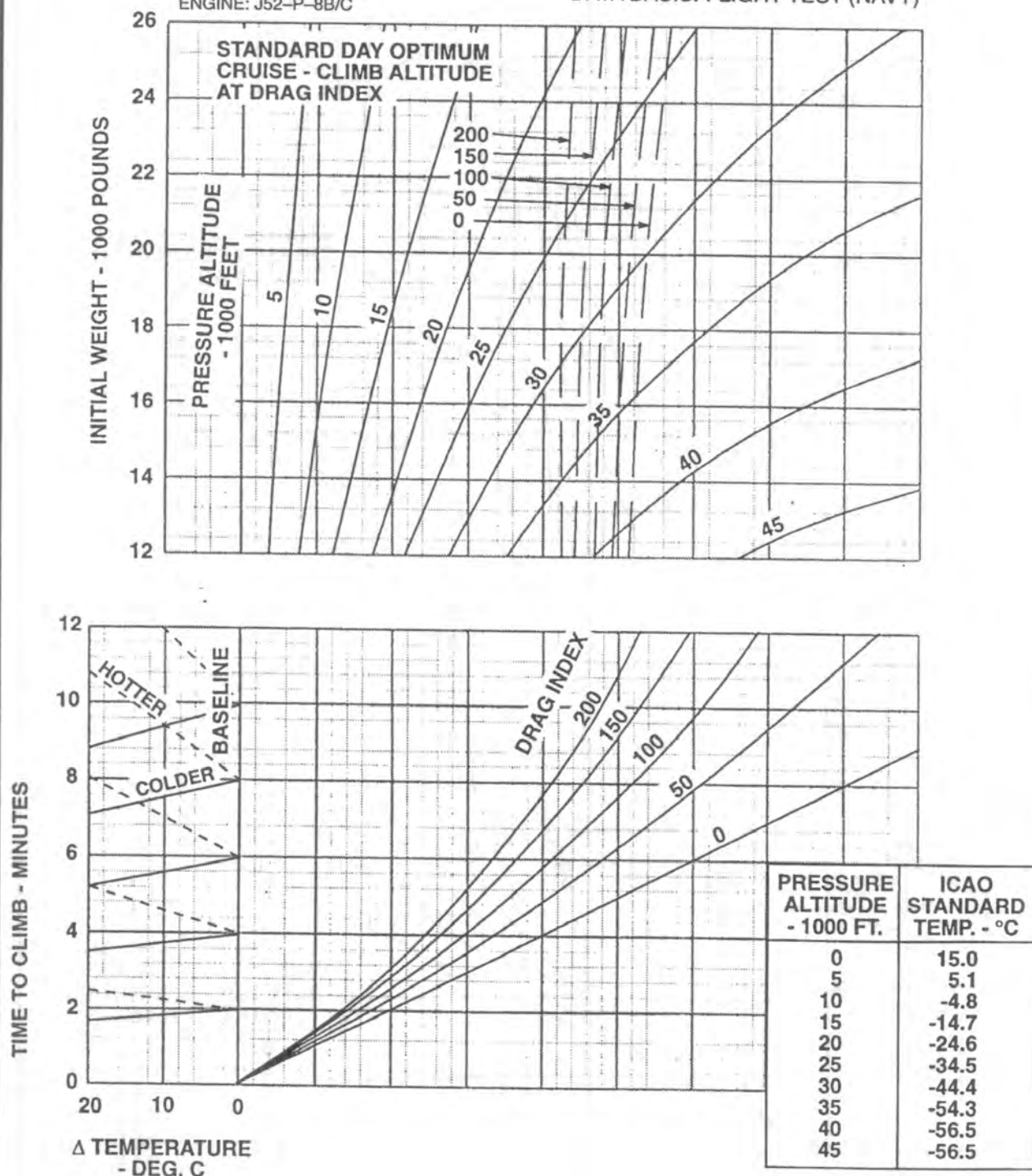


Figure 9-30 Climb Time A-4

AL 7(0)

MILITARY THRUST CLIMB TIME TO CLIMB

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

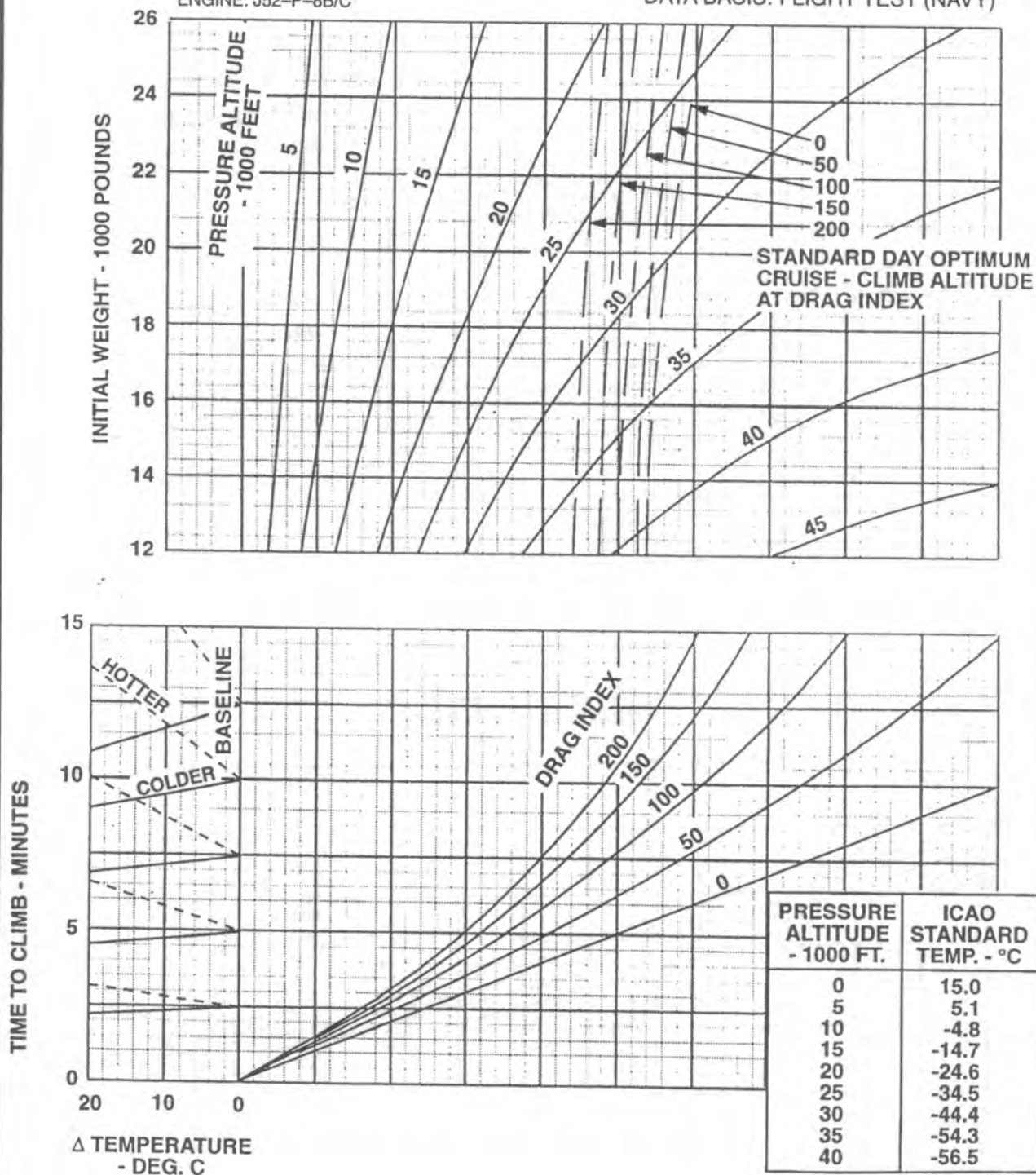


Figure 9-31 Climb Time TA-4

COMBAT CEILING AND OPTIMUM CRUISE ALTITUDE **ICAO STANDARD ATMOSPHERE**

MODEL: A-4E/F
 ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
 DATA BASIS: FLIGHT TEST (NAVY)

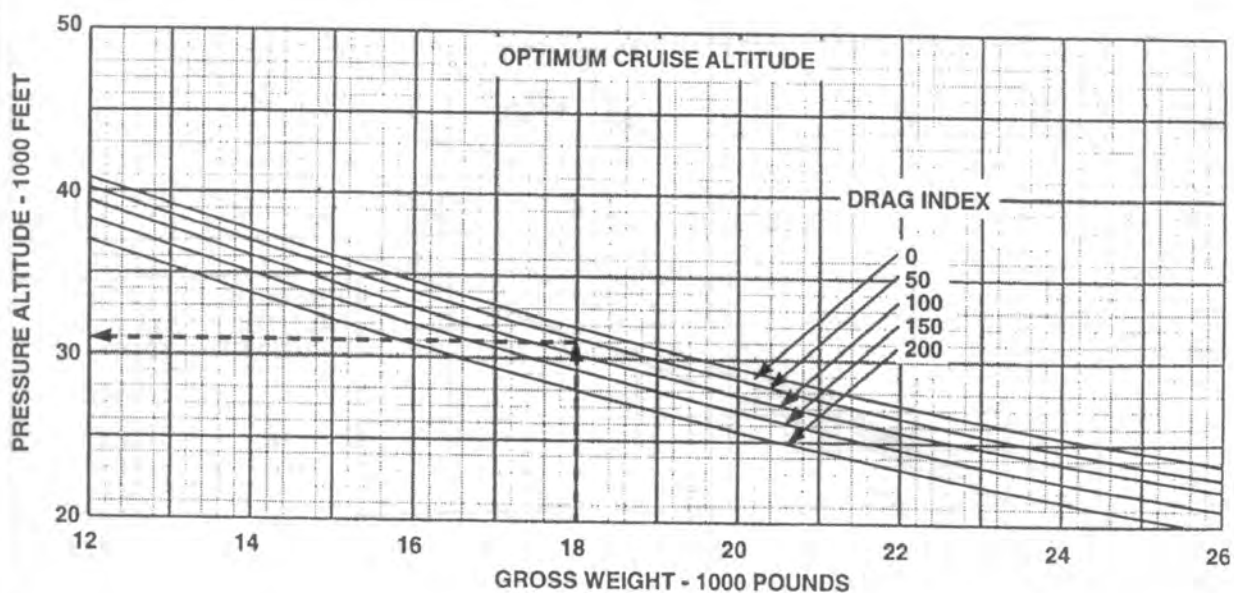
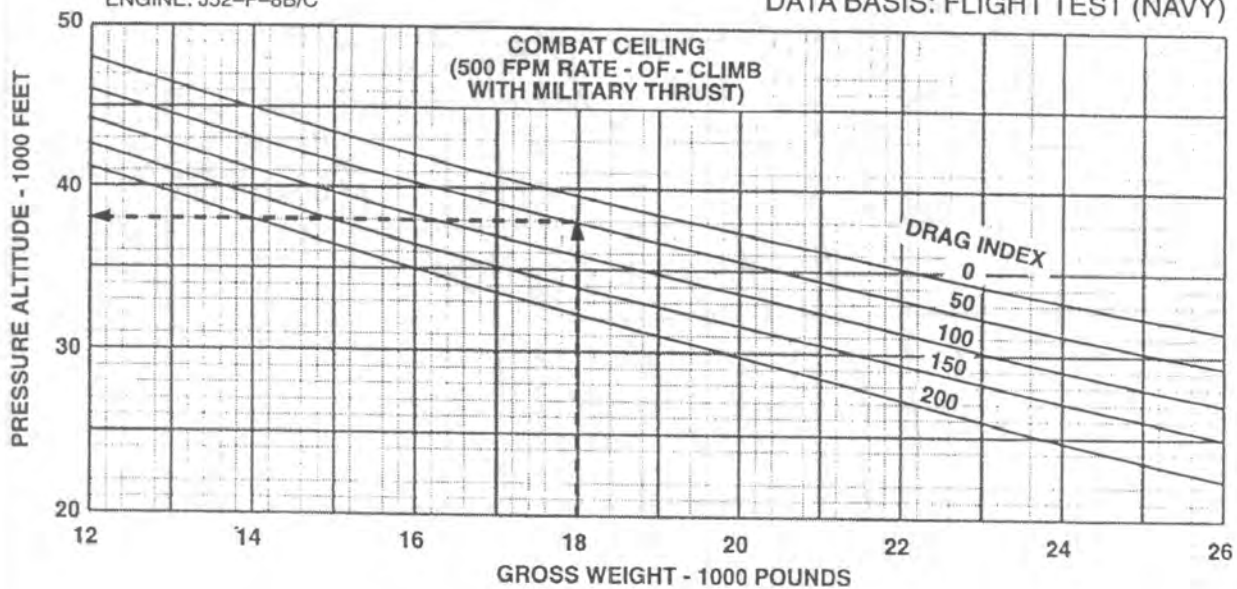


Figure 9-32 Combat Ceiling And Optimum Cruise Altitude A-4

AL 7(0)

COMBAT CEILING AND OPTIMUM CRUISE ALTITUDE ICAO STANDARD ATMOSPHERE

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

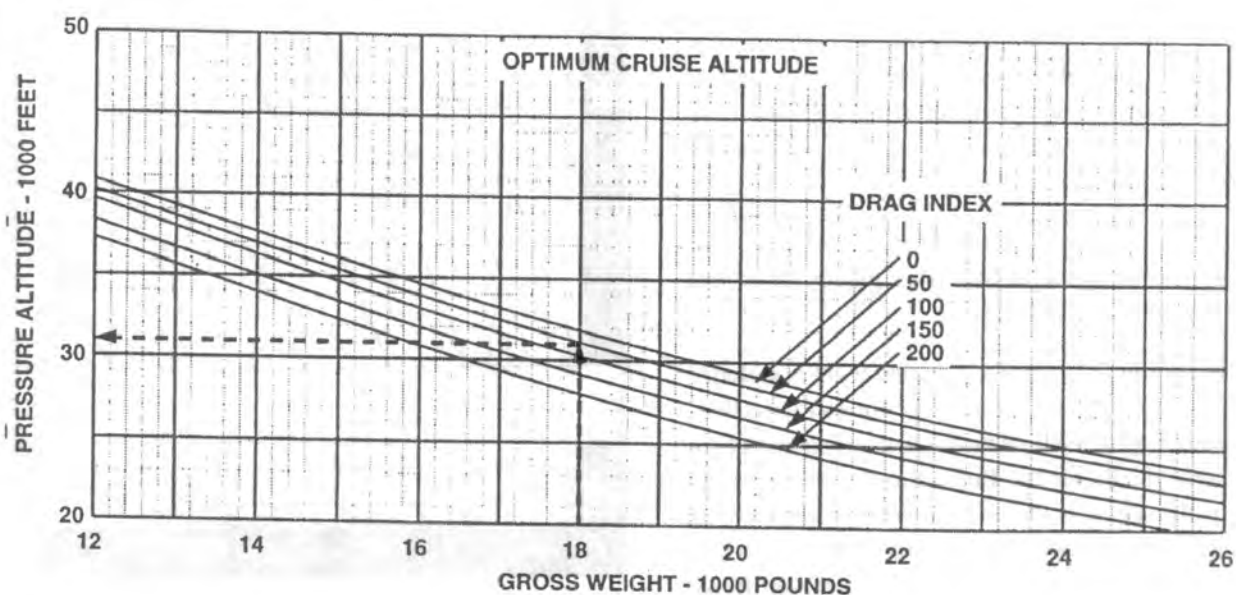
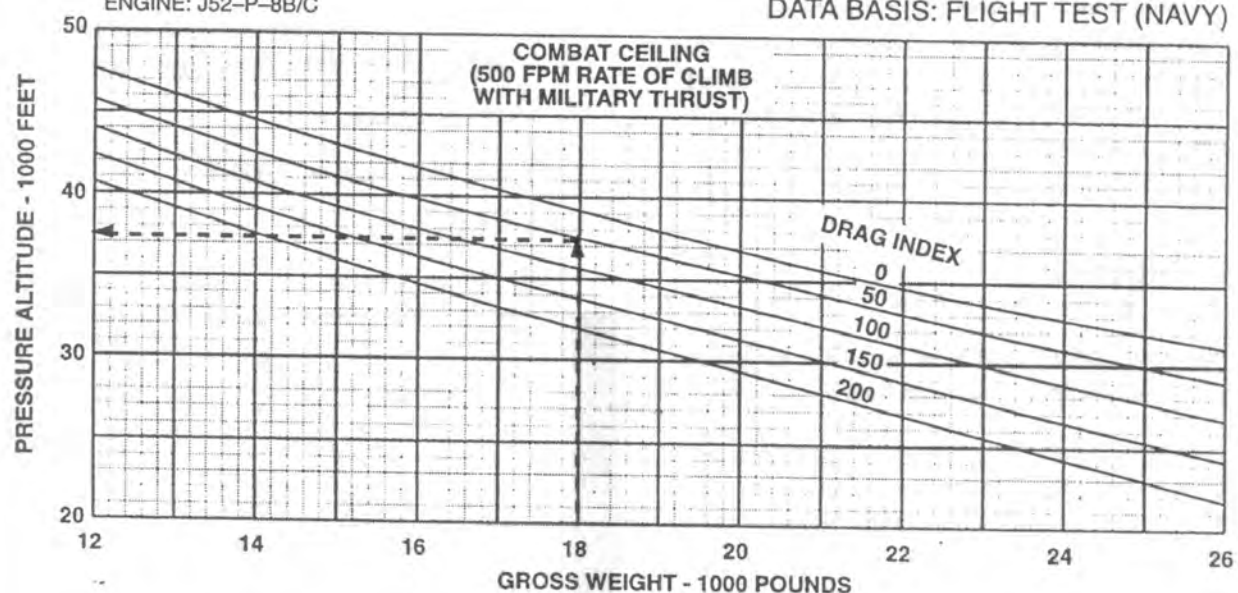


Figure 9-33 Combat Ceiling and Optimum Cruise Altitude TA-4

RANGE

RANGE FACTOR CHART

9.35 The range factor chart (Figure 9-47) provides a means of correcting specific (or total) range for existing wind effects. The presented range factors consider wind speeds up to 120 knots from any relative wind direction for aircraft speeds of 350 to 500 KTAS.

Use

9.36 Determine the relative wind direction by measuring the angular difference between the aircraft heading and the true wind direction. At a given wind direction, wind speed, and aircraft true airspeed, read the range factor. Multiply the specific range by this range factor to obtain specific range as affected by wind.

BINGO RANGE

9.37 Occasions arise when it is necessary to initiate recovery and obtain maximum range from the aircraft.

9.38 The Bingo range charts (Figure 9-48) tabulate the range distances obtainable for various quantities of fuel on board at both the initial altitude and the optimum. Best range altitude. Climb speeds and airspeeds for maximum range are included in the charts as well as letdown instructions.

9.39 The time at which letdown should be initiated is given in terms of fuel on board, and represents the fuel required to conduct a maximum range descent from altitude to sea level. An 800 pound fuel allowance is included for approach and landing.

9.40 The Bingo Range chart is provided for an aircraft configuration consisting of four wing pylons, guns, and two 300-gallon external fuel tanks.

9.41 In addition, for the TA-4 Figure 9-49 is included for Bingo Range in graphic form. The Bingo Range Plots presented in Figure 9-49 allow quick interpolation of the Bingo problem. To use the Bingo Range Plots, pressure altitude and distance, or fuel on board must be known. With these known conditions, the fuel required on board or Bingo distance (climb, cruise, and descent) or Bingo distance (constant altitude cruise) can be determined.

TA-4K Bingo Range—Fuel On Board Required or Bingo Constant Cruise

(For Figure 9-49)

9.42 Climb to Altitude:

- (A) Pressure altitude 15,000 ft
- (B) Bingo range 96 NMI
- (C) Fuel on board required 1215 lb
- (D) Climb to 36,200 feet using 310 KCAS to Mach 0.71 as climb Speed. Start descent at 62 NMI.

9.43 Maintain Altitude:

- (E) Constant cruise at 15,000 ft
- (F) Bingo range 82 NMI
- (G) Descent starts at 24 NMI

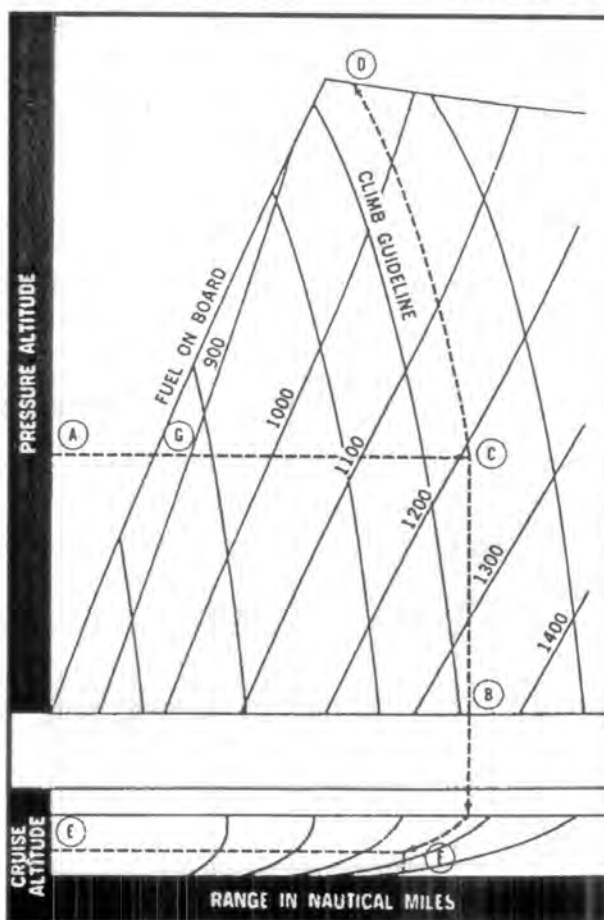


Figure 9-34 Sample Bingo Range Plot

SAMPLE PROBLEM

Long Range Cruise

9.44 The long range cruise charts are shown in Figure 9-50 to Figure 9-53. Long range cruise is defined as the highest Mach number which will result in 99 percent of the maximum miles per pound of fuel. Essentially, long range cruise permits an increase of 20 to 35 knots in airspeed for an increase of 1 percent in fuel consumption. To use the long range cruise charts, average gross weight, drag index, ambient temperature, and desired cruise altitude must be known for a given cruise leg. With these known conditions, long range cruise Mach number, engine power setting in terms of EPR, and specific range (nautical miles per pound of fuel) can be determined. The optimum long range cruise altitudes are also shown and are the altitudes that will produce the maximum miles per pound of fuel at the long range cruise condition.

SAMPLE PROBLEM

Long Range Cruise – Mach Number and EPR

(For Figure 9-50)

- (A) Average gross weight 18,000 lb
- (B) Cruise altitude 25,000 ft
- (C) Drag index 100
- (D) Mach number 0.65
- (E) EPR 2.22

Long Range Cruise – Nautical Miles per Pound of Fuel

(For Figure 9-52)

- (F) Average gross weight 18,000 lb
- (G) Pressure altitude 25,000 ft
- (H) Temperature deviation from ICAO Standard (Ambient temperature = 24.5°C) +10°C
- (J) Drag index 100
- (K) Pressure altitude 25,000 ft
- (L) Ambient temperature -24.5°C
- (M) Nautical miles per pound of fuel 0.164

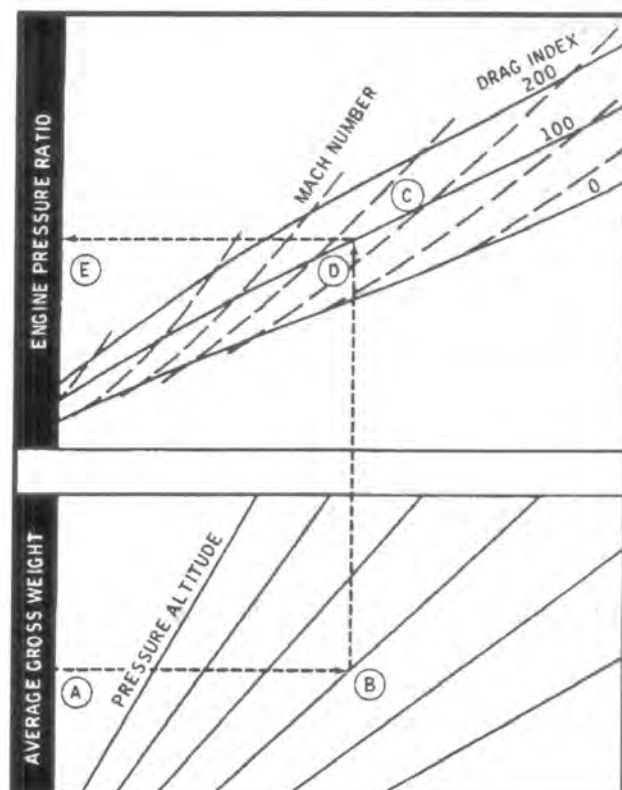


Figure 9-35 Sample Long Range Cruise Mach Number And EPR

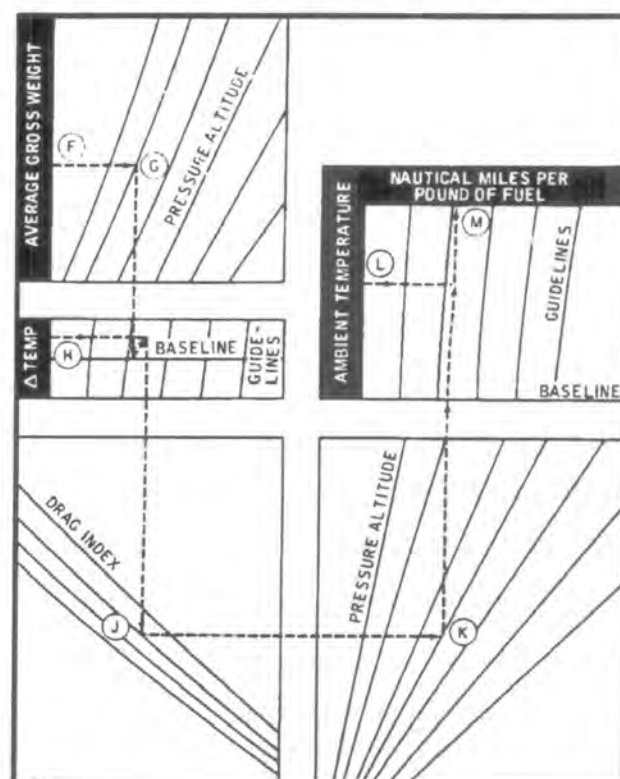


Figure 9-36 Sample Long Range Cruise Nautical Miles Per Pound Of Fuel

Maximum Range Cruise

9.45 Maximum range cruise charts, shown in Figure 9-54 to Figure 9-57 present the necessary mission planning data to set up maximum range cruise schedules for a constant cruise altitude. To use the maximum range charts, the average gross weight, cruise altitude, drag index, ambient air temperature, relative wind, and ground distance to be covered must be known. It is then possible to determine true Mach number, true airspeed, time enroute, nautical miles per pound of fuel, fuel flow, and total fuel required. Optimum cruise altitude (altitude for best range) lines are superimposed on the pressure altitude plot.

SAMPLE PROBLEM

Maximum Range Cruise – Time and Speed

(For Figure 9-54)

- (A) Average gross weight for
cruise leg 18,000lb
- (B) Cruise altitude 25,000 ft
- (C) Drag index 100
- (D) True Mach number 0.615
- (E) Ambient air temperature at
cruise altitude (ICAO standard
temperature +10°C) -24.5°C
- (F) True airspeed 380 Kts
- (G) Tailwind 50 Kts
- (H) Ground distance 200 NMI
- (J) Time 28.0 min

Maximum Range Cruise – Nautical Miles Per Pound Of Fuel

(For Figure 9-56, sheet 1)

- (K) Average gross weight 18,000 lb
- (L) Cruise altitude 25,000 ft
- (M) Temperature deviation from
ICAO standard (Ambient
temperature = -24.5°C) +10°C
- (N) Drag index 100
- (P) Cruise altitude 25,000 ft
- (Q) Ambient temperature -24.5°C
- (R) Nautical miles per
pound of fuel 0.166 NMI/lb

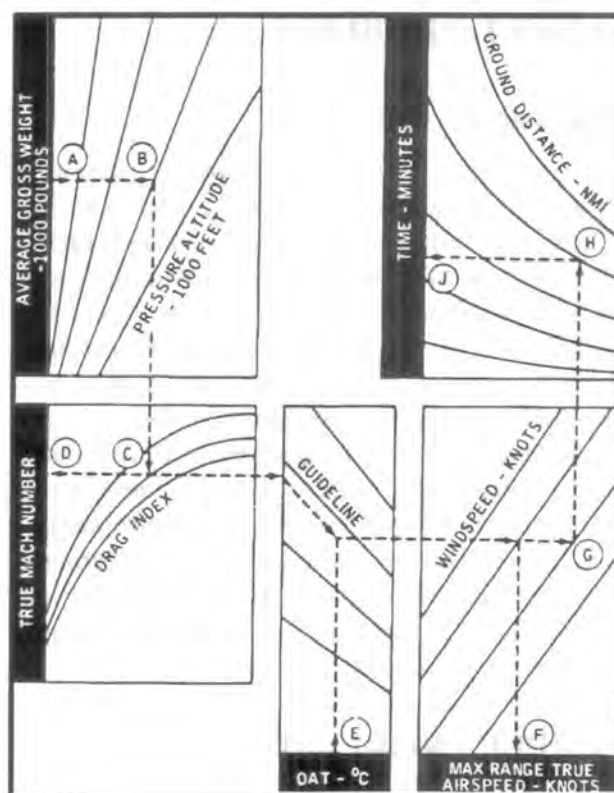


Figure 9-37 Sample Maximum Range Cruise – Time And Speed

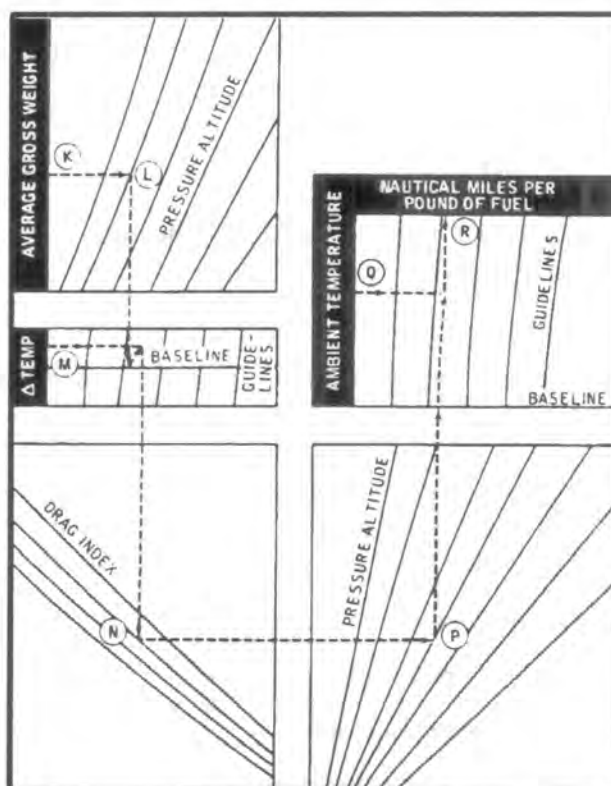


Figure 9-38 Sample Maximum Range Cruise – Nautical Miles Per Pound Of Fuel

Maximum Range Cruise – Fuel

(For Figure 9–56, sheet 2)

- (S) Nautical miles per pound of fuel 0.166 NMI/lb
 (T) Maximum range true airspeed 380 KTAS
 (W) Fuel flow 2300 lb/hr
 (X) Time 28.0 min
 (Y) Total fuel required 1070 lb

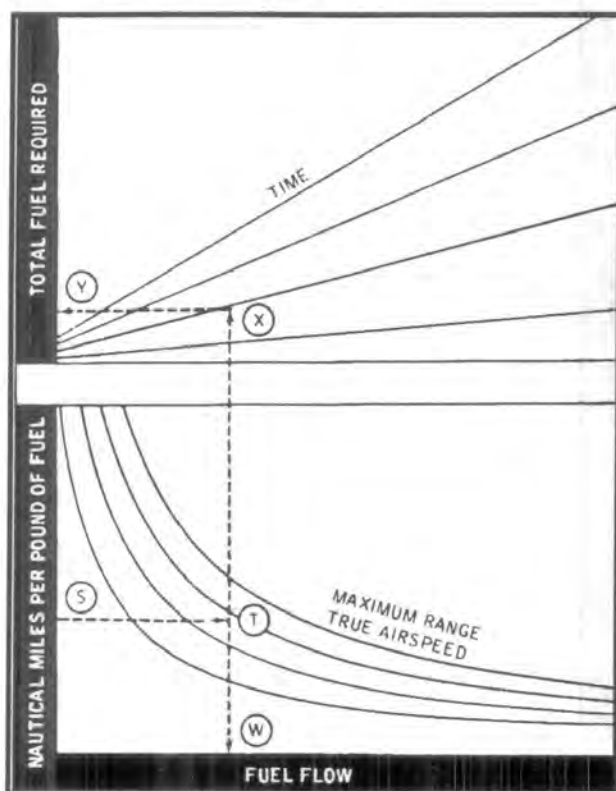


Figure 9–39 Sample Maximum Range Cruise –Fuel

NAUTICAL MILES PER POUND OF FUEL

9.46 Nautical miles per pound of fuel charts (Figure 9–58 and Figure 9–59, sheets 1 through 6) present cruise data throughout the gross weight, airspeed, and drag index range of the aircraft. These data are presented for use when cruise data are required for speed conditions other

than maximum range or long range cruise. To use the nautical miles per pound of fuel charts, the average gross weight, pressure altitude, cruise Mach number, drag index, and ambient air temperature must be known. It is then possible to determine true airspeed, nautical miles per pound of fuel, fuel flow, and engine pressure ratio.

SAMPLE PROBLEM

Nautical Miles Per Pound of Fuel

(For Figure 9–58, sheet 1)

- (A) Average gross weight. 14,000 lb
 (B) Cruise pressure altitude 30,000 ft
 (C) Drag index = 0 (baseline)
 (D) Cruise Mach number 0.75
 (E) Thrust required/ δ amb clean aircraft 5700

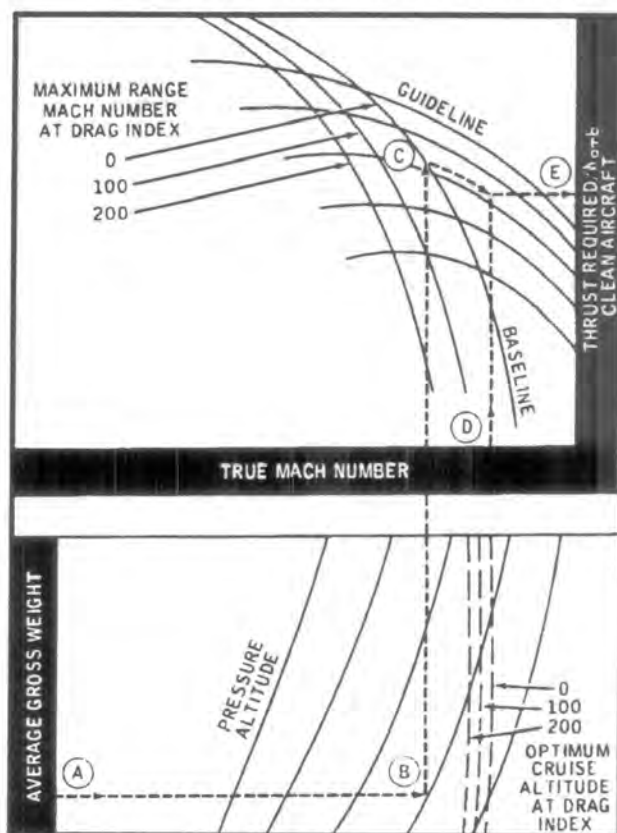


Figure 9–40 Sample Nautical Miles Per Pound Of Fuel

Nautical Miles Per Pound of Fuel

(For Figure 9-58, sheet 2)

- (F) Thrust required/ δ_{amb} clean aircraft 5700
- (G) Cruise Mach number 0.75
- (H) Drag index 100
- (J) Total thrust required/ δ_{amb} 8300

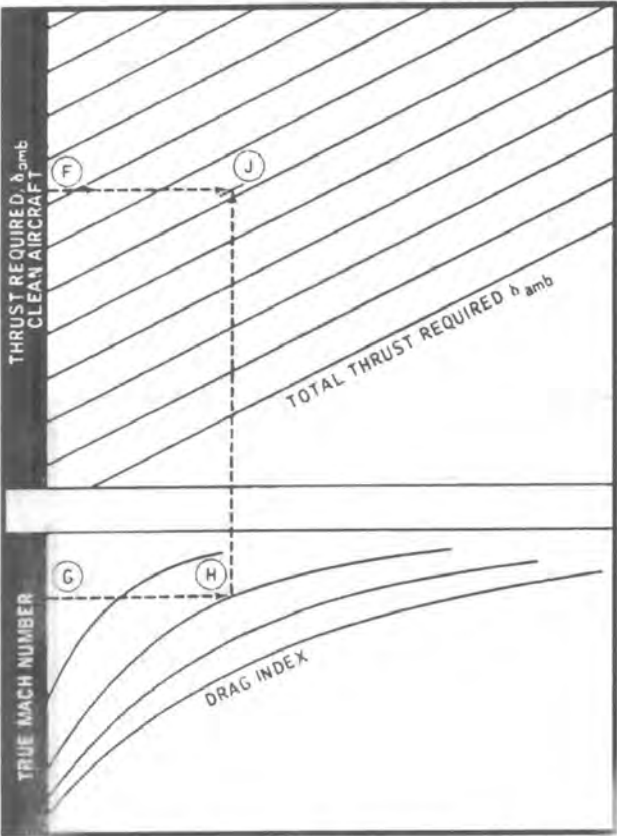


Figure 9-41 Sample Nautical Miles Per Pound Of Fuel

Nautical Miles Per Pound of Fuel

(For Figure 9-58 sheet 3)

- (K) Ambient air temperature -44.4°C
- (L) Pressure altitude 30,000 ft
- (M) Cruise Mach number 0.75
- (N) Reynolds number index (RNI) 0.503

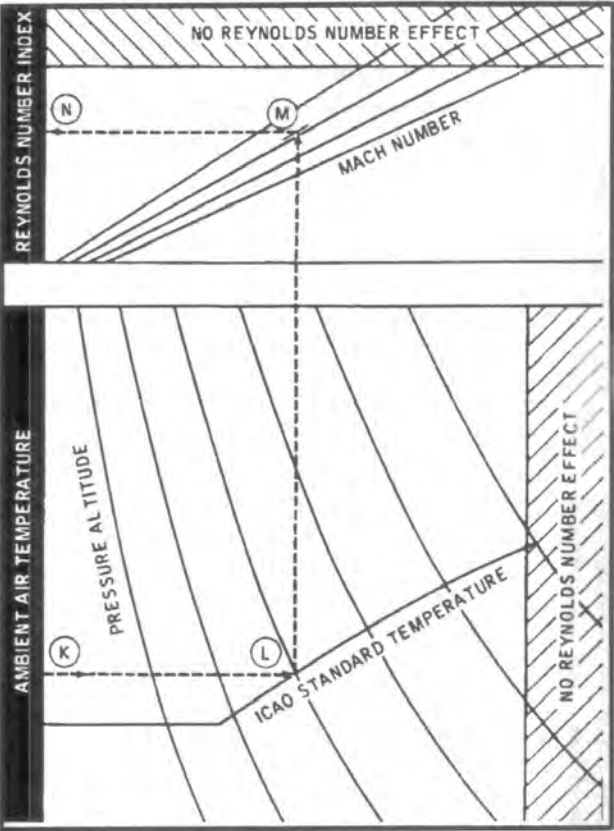


Figure 9-42 Sample Nautical Miles Per Pound Of Fuel

Nautical Miles Per Pound of Fuel

(For Figure 9-58, sheet 4)

- (P) Total thrust required/ δ amb 8300 lb
- (Q) Cruise Mach number 0.75
- (R) Generalized fuel flow parameter
(uncorrected for Reynolds
number effect) 5.80
- (S) Reynolds number index (RNI) 0.503
- (T) Generalized fuel flow parameter
(corrected for Reynolds
number effect) 6.00

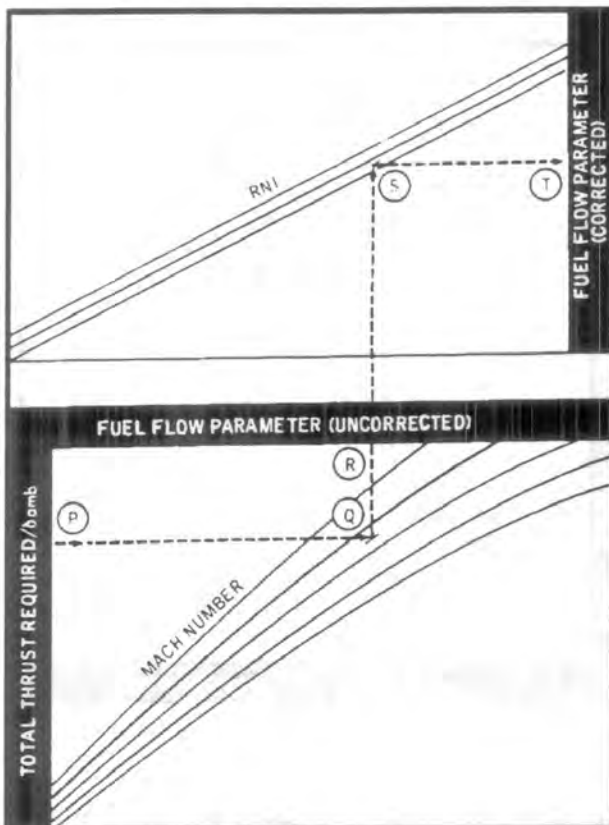


Figure 9-43 Sample Nautical Miles Per Pound Of Fuel

Nautical Miles Per Pound of Fuel

(For Figure 9-58, sheet 5)

- (U) Generalized fuel flow
parameter (corrected for
Reynolds number effect) 6.00
- (V) Cruise Mach number 0.75
- (W) Pressure altitude 30,000 ft
- (X) Ambient air temperature -44.4°C
- (Y) Nautical miles per
pound of fuel 0.187

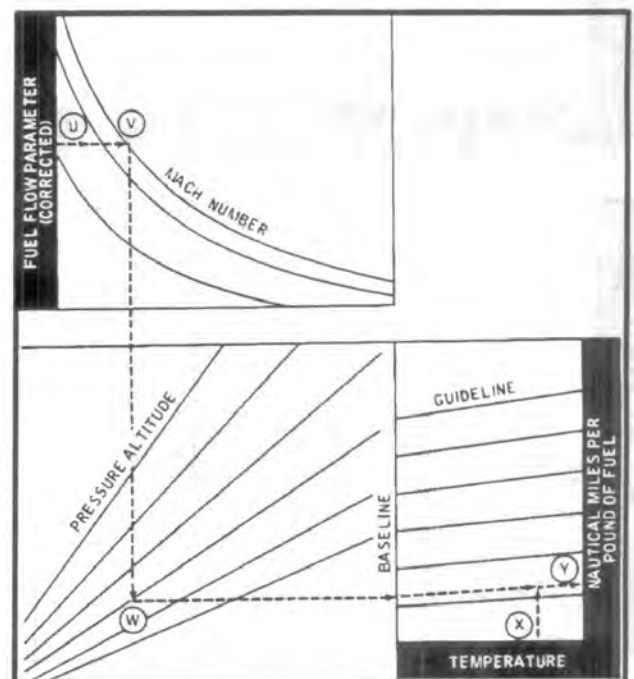


Figure 9-44 Sample Nautical Miles Per Pound Of Fuel

Nautical Miles Per Pound of Fuel

(For Figure 9-58, Sheet 6)

- (A) True Mach number 0.75
- (B) Ambient air temperature -44.4°C
- (C) True airspeed 442 Kts
- (D) Nautical miles per pound of fuel 0.187
- (E) Fuel flow 2350 lb/hr

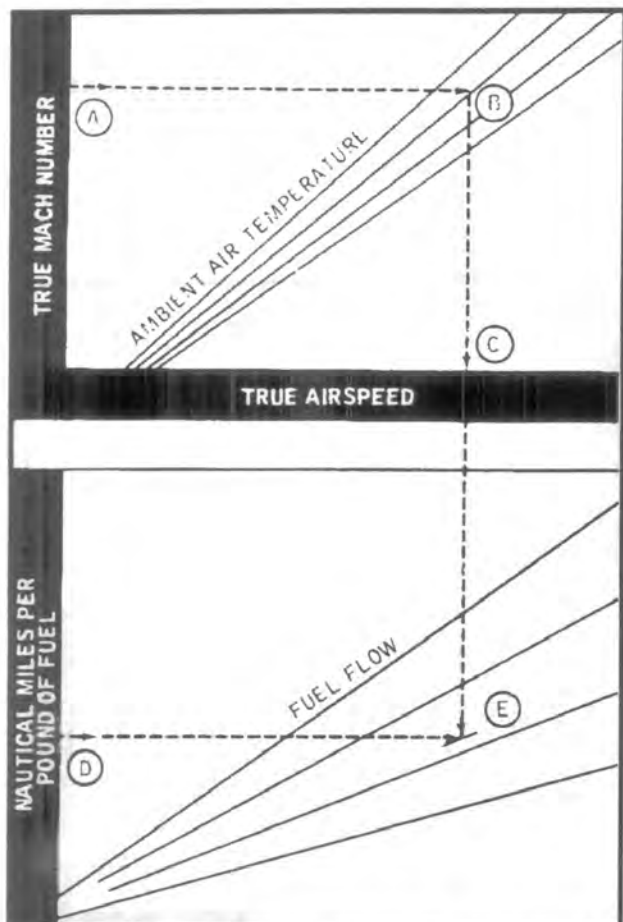


Figure 9-45 Sample Nautical Miles Per Pound Of Fuel

SAMPLE PROBLEM

Engine Pressure Ratio for Cruise

(For Figure 9-60)

- (F) Total thrust required/ δ amb 8300 lb
- (G) True Mach number 0.75
- (H) Engine pressure ratio 2.38

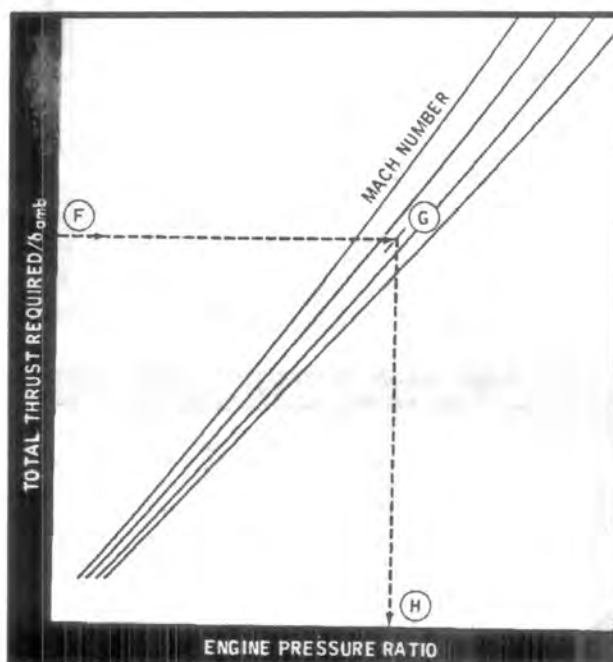


Figure 9-46 Sample Engine Pressure Ratio For Cruise

RANGE FACTOR CHART

Relative Wind – Degrees	KTAS	Wind Speed – Knots				
		40	60	80	100	120
0° Headwind	350	0.886	0.829	0.772	0.714	0.657
	400	0.900	0.850	0.800	0.750	0.700
	450	0.911	0.867	0.822	0.778	0.733
	500	0.920	0.880	0.844	0.800	0.760
	550	0.927	0.891	0.855	0.818	0.782
30°	350	0.899	0.848	0.796	0.742	0.688
	400	0.912	0.867	0.822	0.776	0.729
	450	0.922	0.882	0.842	0.801	0.760
	500	0.930	0.894	0.858	0.822	0.785
	550	0.936	0.904	0.871	0.839	0.805
60°	350	0.938	0.903	0.866	0.824	0.784
	400	0.946	0.917	0.885	0.852	0.816
	450	0.953	0.927	0.889	0.870	0.840
	500	0.958	0.935	0.910	0.885	0.858
	550	0.962	0.941	0.919	0.897	0.873
90°	350	0.994	0.985	0.974	0.959	0.941
	400	0.995	0.989	0.980	0.969	0.955
	450	0.996	0.991	0.984	0.975	0.964
	500	0.997	0.992	0.987	0.980	0.971
	550	0.997	0.994	0.989	0.984	0.976
120°	350	1.062	1.097	1.134	1.176	1.216
	400	1.054	1.083	1.115	1.148	1.184
	450	1.047	1.073	1.101	1.130	1.160
	500	1.042	1.065	1.090	1.115	1.142
	550	1.038	1.059	1.081	1.103	1.127
150°	350	1.101	1.152	1.205	1.258	1.312
	400	1.088	1.133	1.178	1.224	1.271
	450	1.078	1.118	1.158	1.199	1.240
	500	1.070	1.106	1.142	1.178	1.215
	550	1.064	1.096	1.129	1.162	1.195
180° Tailwind	350	1.114	1.172	1.228	1.286	1.343
	400	1.100	1.150	1.200	1.250	1.300
	450	1.089	1.133	1.178	1.222	1.267
	500	1.080	1.120	1.160	1.200	1.240
	550	1.073	1.109	1.146	1.182	1.218

Figure 9-47 Range Factor Chart

BINGO RANGE

Drag Index = 73

Aircraft Weight (Less Fuel) = 12,116 Pounds

All Pylons, Guns (No Ammo), and Two 300 Gallon External Tanks

Reserve Fuel for Landing = 800 Pounds

Model: A-4F

Engine: J52-P-8A/B

Data as of: 15 November 1972

Data Basis: Flight Test (Navy)

FUEL BOARD POUNDS	IF YOU ARE AT SEA LEVEL			IF YOU ARE AT 10,000 FEET			IF YOU ARE AT 20,000 FEET		
	RANGE AT		OPTIMUM CRUISE ALTITUDE	RANGE AT		OPTIMUM CRUISE ALTITUDE	RANGE AT		OPTIMUM CRUISE ALTITUDE
	SEA LEVEL	OPTIMUM ALTITUDE		10, 000 FEET	OPTIMUM ALTITUDE		20,000 FEET	OPTIMUM ALTITUDE	
	nmi	nmi	feet	nmi	nmi	feet	nmi	nmi	feet
	2700	208	414	35,000	282	438	35,000	376	462
2500	186	369	35,000	254	392	35,000	339	416	35,000
2300	165	323	35,000	225	346	35,000	302	370	35,000
2100	143	276	35,000	197	299	35,000	265	323	35,000
1900	121	228	35,000	169	252	35,000	228	275	35,000
1700	99	181	35,000	140	204	35,000	190	228	35,000
1500	77	132	35,000	111	156	35,000	152	179	35,000
1300	55	84	30,000	83	107	35,000	114	130	35,000
1100	33	44	15,000	54	61	25,000	76	81	35,000
	IF YOU ARE AT 30,000 FEET			IF YOU ARE AT 35,000 FEET			IF YOU ARE AT 40,000 FEET		
	RANGE AT		OPTIMUM CRUISE ALTITUDE	RANGE AT		CRUISE ALTITUDE	RANGE AT		OPTIMUM CRUISE ALTITUDE
	30,000 LEVEL	OPTIMUM ALTITUDE		35,000 FEET	OPTIMUM ALTITUDE		40,000 FEET	OPTIMUM ALTITUDE	
	nmi	nmi	feet	nmi	nmi	feet	nmi	nmi	feet
	2700	458	481	35,000	489	489	35,000	490	497
2500	414	435	35,000	443	443	35,000	446	451	35,000
2300	370	389	35,000	397	397	35,000	401	405	35,000
2100	325	342	35,000	350	350	35,000	356	358	35,000
1900	280	294	35,000	303	303	35,000	309	311	35,000
1700	235	247	35,000	255	255	35,000	262	263	35,000
1500	190	198	35,000	206	206	35,000	214	214	40,000
1300	144	149	35,000	157	157	35,000	165	165	40,000
1100	97	99	35,000	108	108	35,000	115	115	40,000

PRESSURE ALTITUDE	CLIMB SPEED MILITARY THRUST		CRUISE SPEED	DESCENT SPEED ENGINE IDLE SPEEDBRAKES CLOSED	START LETDOWN FROM ALTITUDE WITH FUEL REMAINING
Feet	KCAS	Mach No.	KCAS	KCAS	Pounds
Sea Level	320		265	185	800
5,000	320		255	185	823
10,000	320		255	185	840
15,000	320		250	185	855
20,000	320		250	185	869
25,000		0.706	250	185	882
30,000		0.706	235	185	895
35,000		0.706	220	185	907
40,000		0.706	210	185	919

Figure 9-48 Bingo Range (Sheet 1 of 2)

AL 7(0)

BINGO RANGE										
Drag Index = 61										
Aircraft Weight (Less Fuel) = 12, 816 Pounds										
All Pylons, Guns (No Ammo), and Two 300 Gallon External Tanks										
Reserve Fuel for Landing = 800 Pounds										
Model: TA-4F					Data as of: 1 MAY 1972					
Engine: J52-P-8B/C					Data Basis: FLIGHT TEST (NAVY)					
FUEL BOARD POUNDS	IF YOU ARE AT SEA LEVEL			IF YOU ARE AT 10,000 FEET			IF YOU ARE AT 20,000 FEET			
	RANGE AT		OPTIMUM CRUISE ALTITUDE	RANGE AT		OPTIMUM CRUISE ALTITUDE	RANGE AT		OPTIMUM CRUISE ALTITUDE	
	SEA LEVEL	OPTIMUM ALTITUDE		10, 000 FEET	OPTIMUM ALTITUDE		20,000 FEET	OPTIMUM ALTITUDE		
	nmi	nmi	feet	nmi	nmi	feet	nmi	nmi	feet	
	2700	208	402	35,000	281	425	35,000	372	448	35, 000
	2500	186	358	35,000	253	381	35, 000	335	403	35, 000
	2300	165	313	35,000	225	337	35,000	299	359	35, 000
	2100	143	268	35,000	197	292	35,000	262	314	35, 000
	1900	121	223	35,000	168	246	35,000	226	269	35, 000
	1700	99	177	35,000	140	200	35,000	189	222	35, 000
	1500	77	130	35,000	111	153	35,000	151	176	35, 000
	1300	55	83	30,000	83	106	35,000	114	129	35, 000
	1100	33	44	15,000	54	61	25,000	76	81	35, 000
	IF YOU ARE AT 30,000 FEET			IF YOU ARE AT 35,000 FEET			IF YOU ARE AT 40,000 FEET			
	RANGE AT		OPTIMUM CRUISE ALTITUDE	RANGE AT		OPTIMUM CRUISE ALTITUDE	RANGE AT		OPTIMUM CRUISE ALTITUDE	
	30,000 LEVEL	OPTIMUM ALTITUDE		35,000 FEET	OPTIMUM ALTITUDE		40,000 FEET	OPTIMUM ALTITUDE		
	nmi	nmi	feet	nmi	nmi	feet	nmi nmi	feet		
	2700	449	465	35,000	473	473	35,000	466	480	35, 000
	2500	407	421	35, 000	429	429	35,000	424	437	35, 000
	2300	364	377	35,000	385	385	35, 000	382	392	35, 000
2100	320	332	35, 000	340	340	35,000	339	347	35, 000	
1900	276	286	35,000	294	294	35,000	296	301	35, 000	
1700	232	240	35,000	248	248	35,000	251	255	35, 000	
1500	188	194	35,000	201	201	35, 000	206	209	35, 000	
1300	143	147	35, 000	154	154	35,000	160	162	35, 000	
1100	97	99	35,000	106	106	35,000	113	114	35, 000	
PRESSURE ALTITUDE		CLIMB SPEED MILITARY THRUST		CRUISE SPEED	DESCENT SPEED ENGINE IDLE SPEEDBRAKES CLOSED		START LETDOWN FROM ALTITUDE WITH FUEL DISTANCE REMAINING			
Feet	KCAS	Mach No.	KCAS	KCAS		Pounds/n mi				
Sea Level	310		27	190		800/0				
5,000	310		265	190		823/7				
10,000	310		260	190		839/15				
15,000	310		260	190		853/23				
20,000	310		260	190		867/32				
25,000		0.71	255	190		880/40				
30,000		0.71	240	190		892/49				
35,000		0.71	225	190		904/59				
40,000		0.71	215	190		916/69				

Figure 9-48 Bingo Range (Sheet 2 of 2)

AL 7(0)

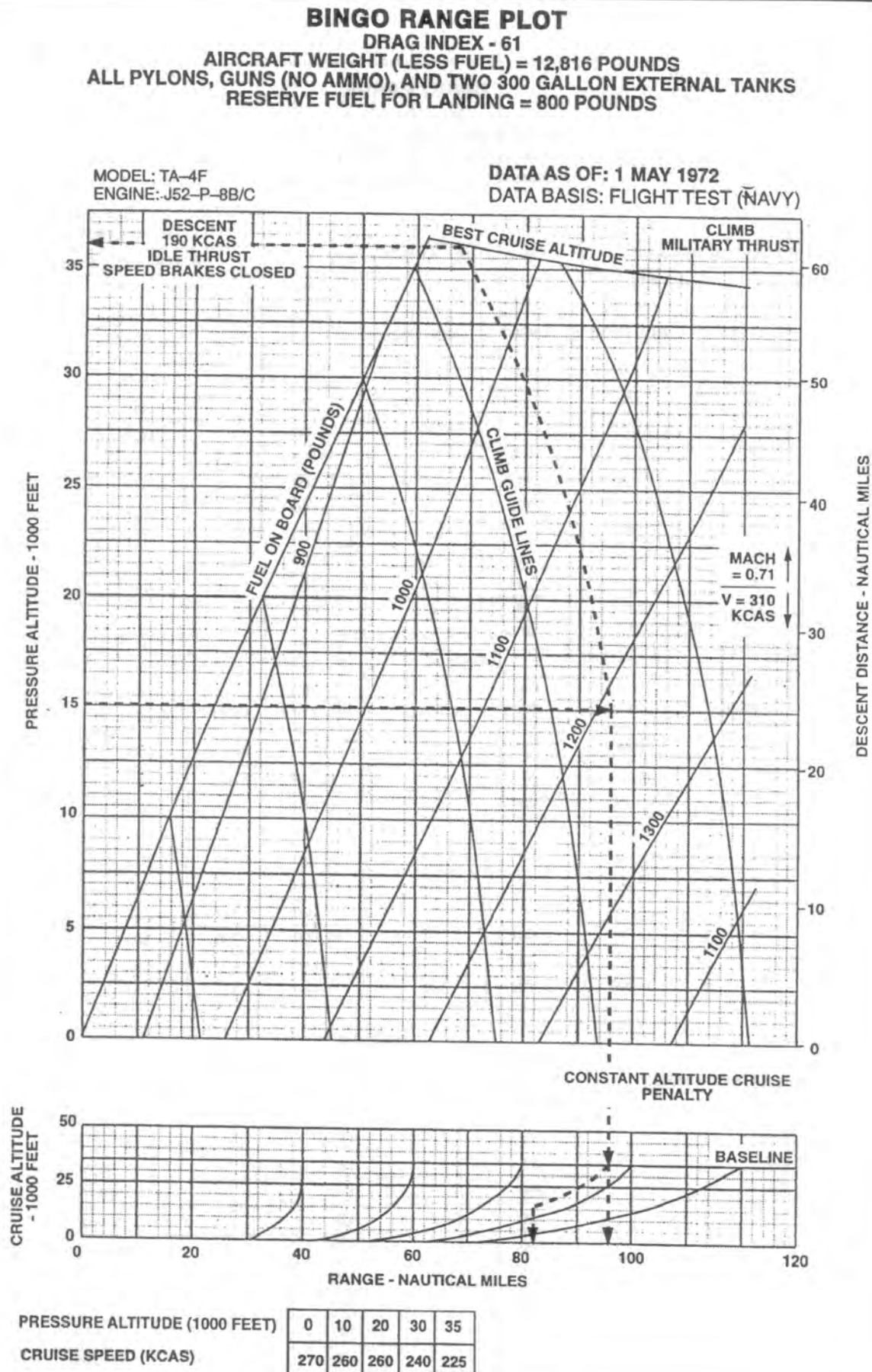


Figure 9-49 Bingo Range Plot

AL 7(0)

LONG RANGE CRUISE **MACH NUMBER AND EPR**

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)

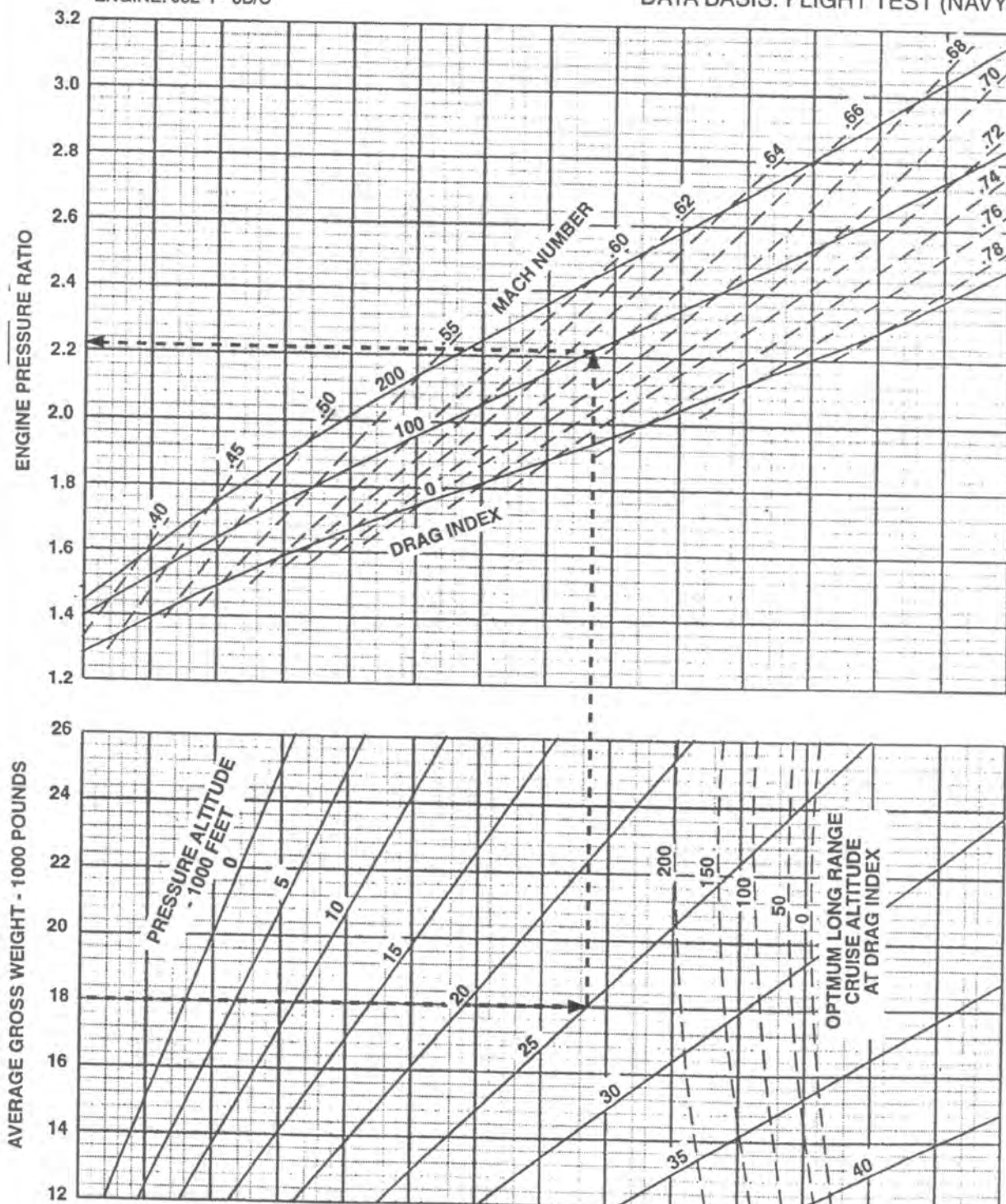


Figure 9-50 Long Range Cruise - Mach Number & EPR A-4

AL 7(0)

LONG RANGE CRUISE MACH NUMBER AND EPR

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

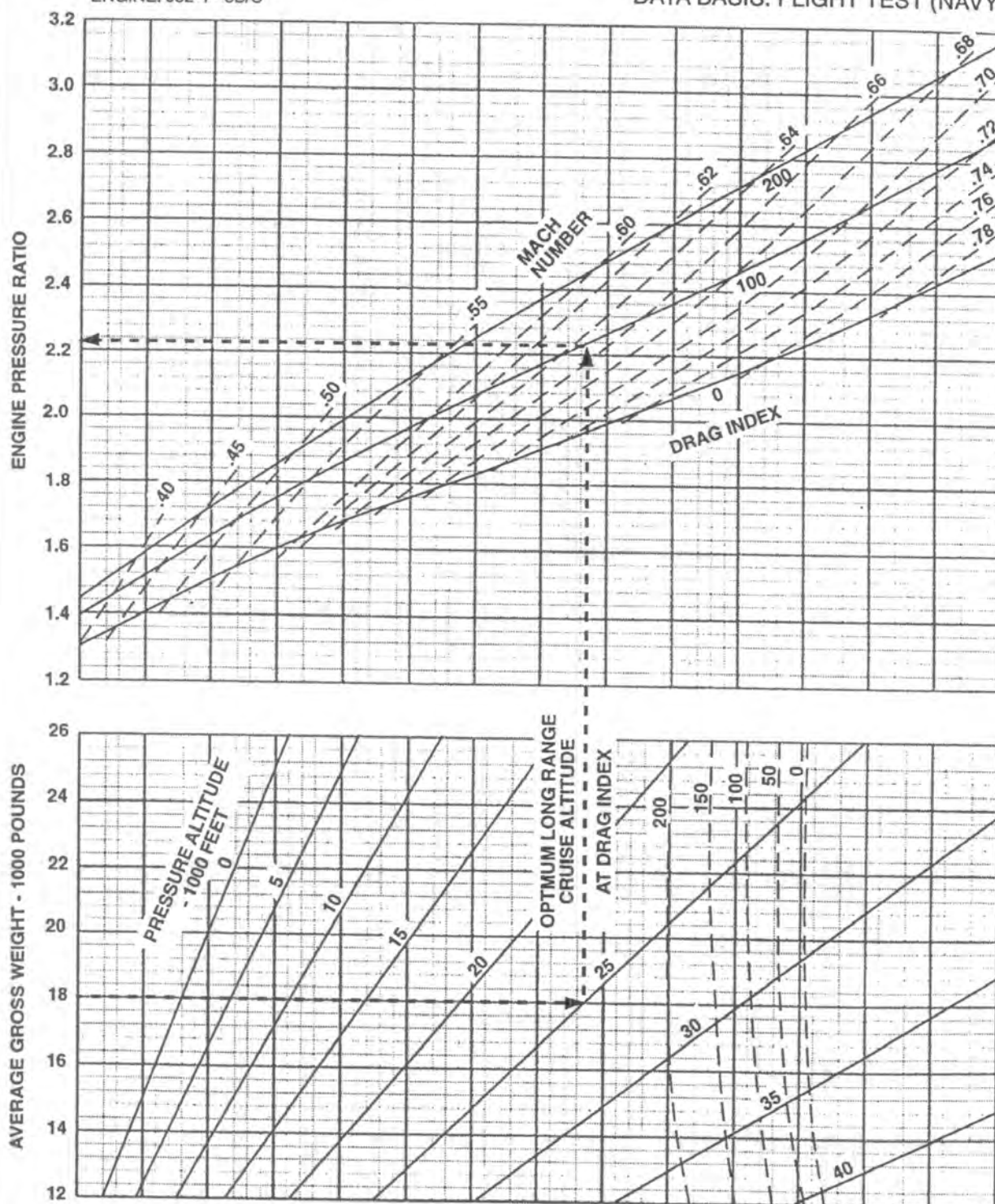


Figure 9-51 Long Range Cruise - Mach Number & EPR TA-4

AL 7(0)

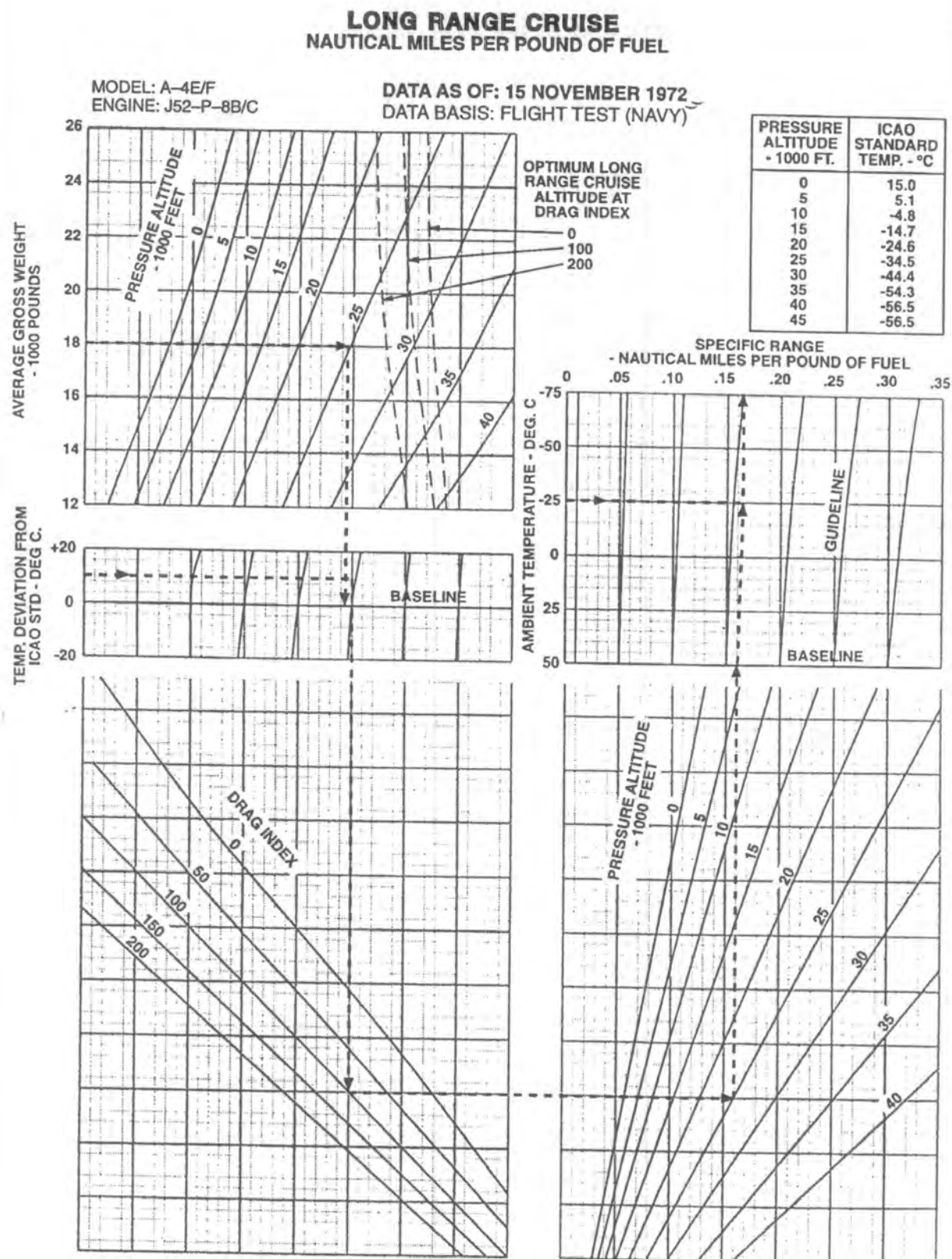


Figure 9-52 Long Range Cruise – Nautical Miles Per Pound Of Fuel A-4

AL 7(0)

LONG RANGE CRUISE NAUTICAL MILES PER POUND OF FUEL

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

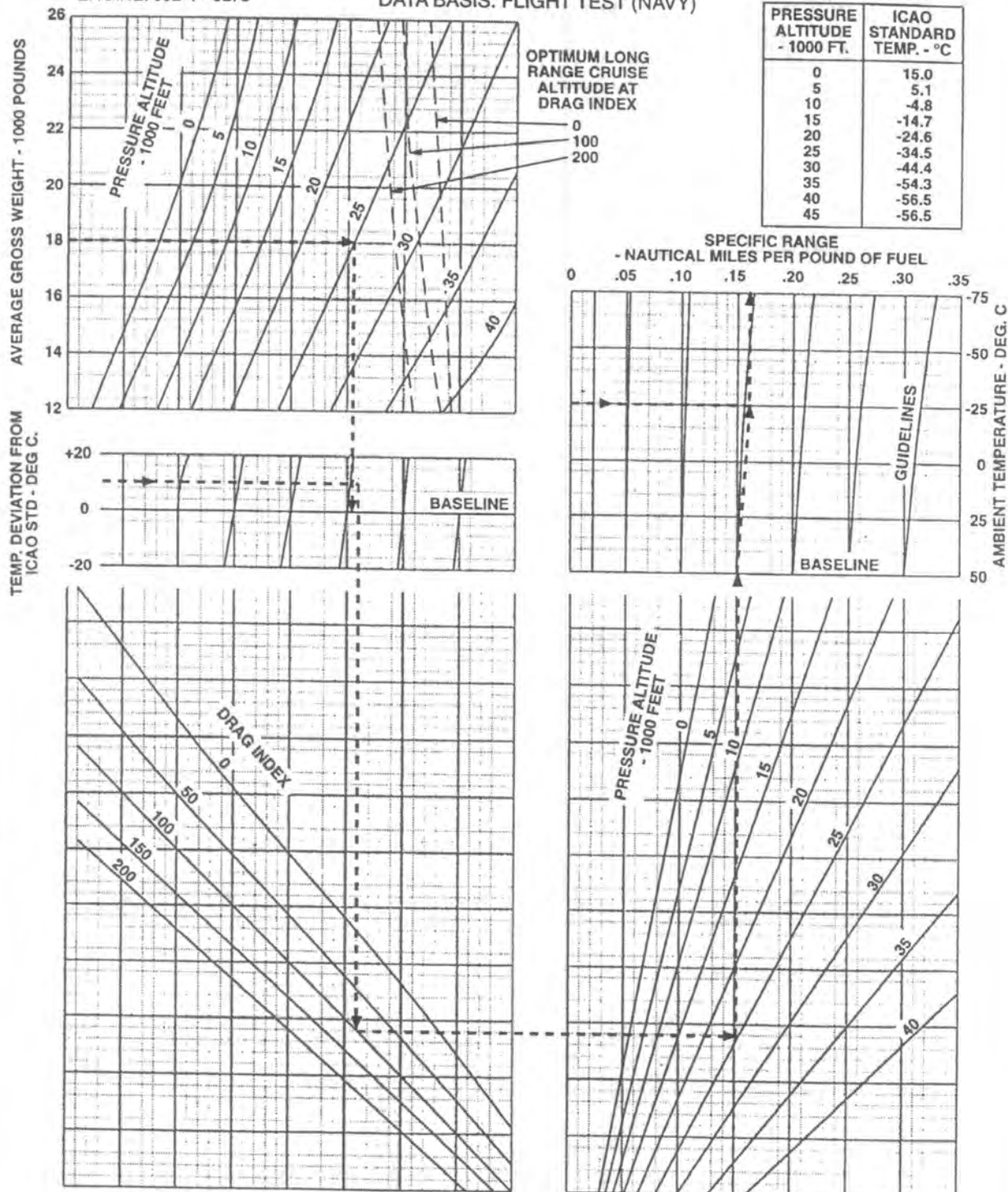


Figure 9-53 Long Range Cruise - Nautical Miles Per Pound Of Fuel TA-4

AL 7(0)

MAXIMUM RANGE CRUISE TIME AND SPEED

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)

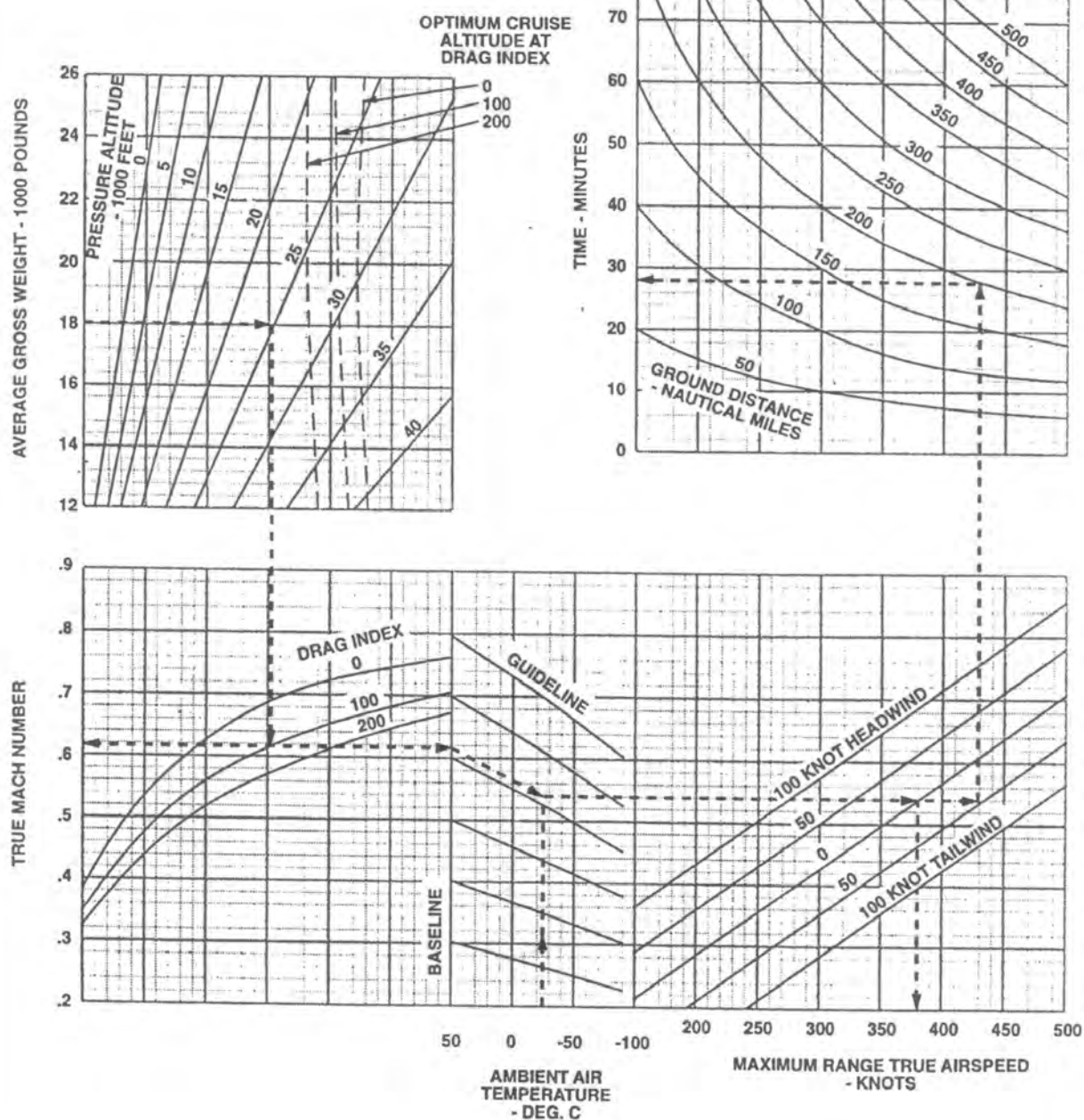


Figure 9-54 Maximum Range Cruise - Time And Speed A-4

AL 7(0)

MAXIMUM RANGE CRUISE **TIME AND SPEED**

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

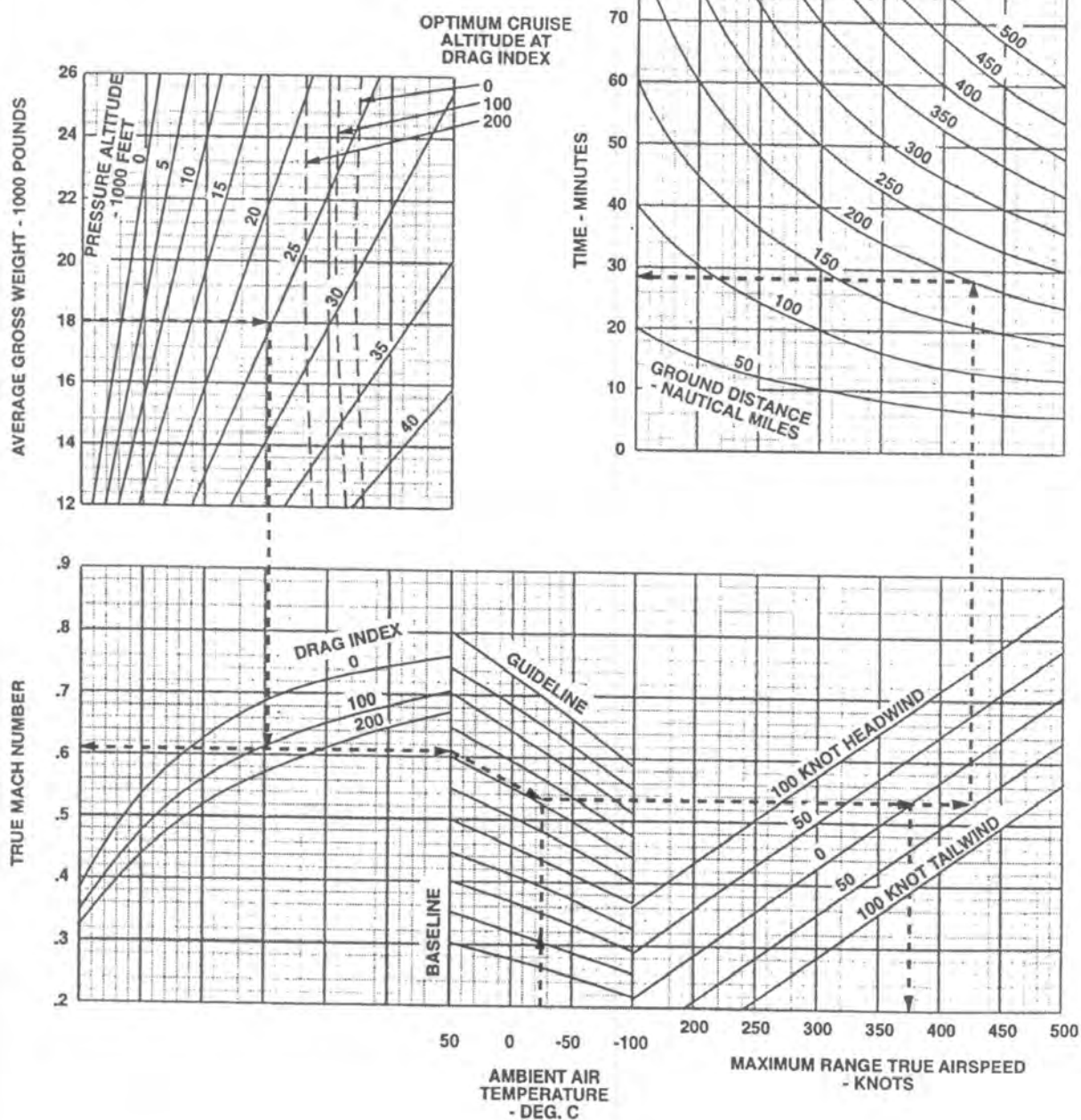


Figure 9-55 Maximum Range Cruise – Time And Speed TA-4

AL 7(0)

MAXIMUM RANGE CRUISE NAUTICAL MILES PER POUND OF FUEL

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)

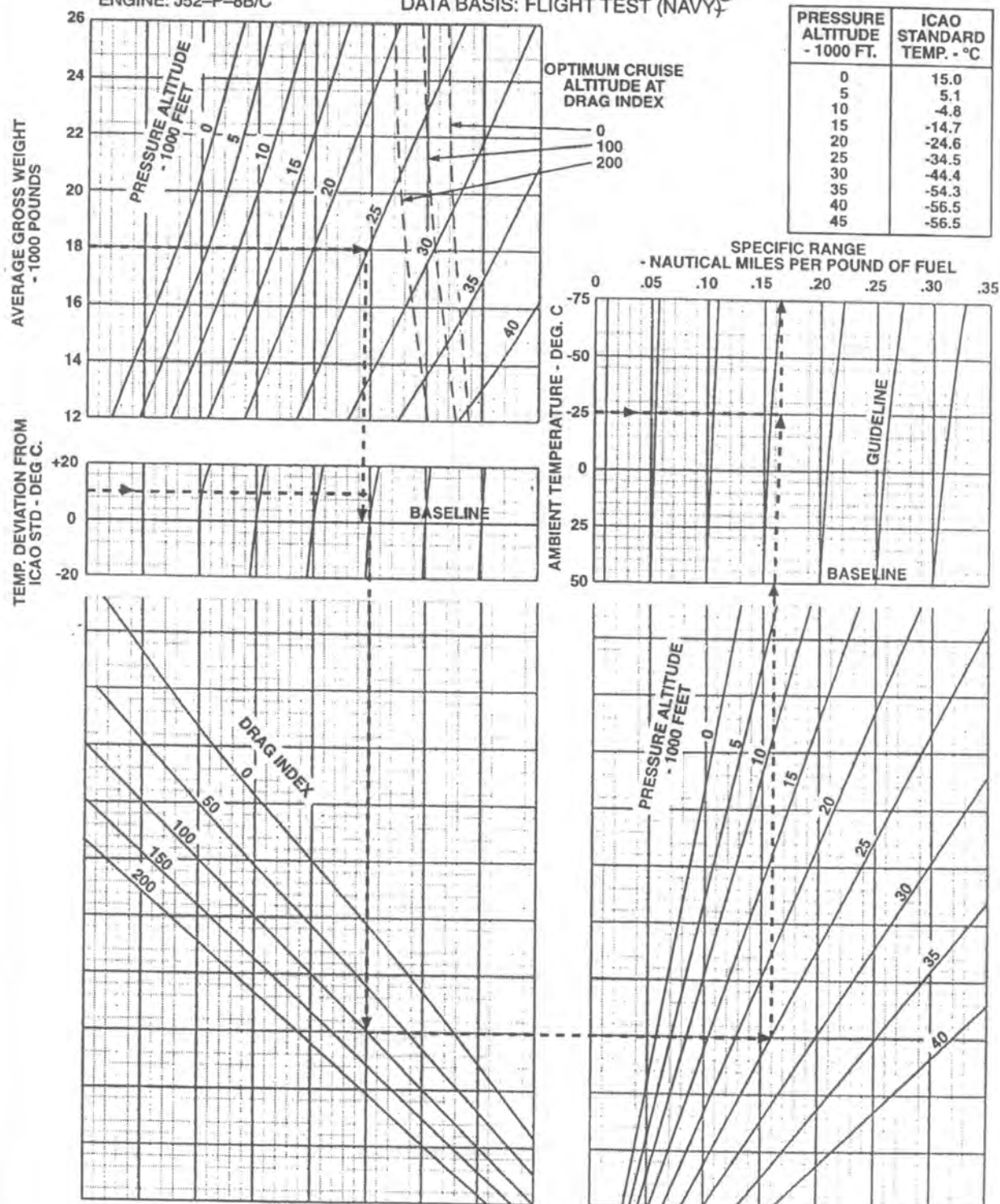


Figure 9-56 Maximum Range Cruise - Fuel A-4 (Sheet 1 of 3)

AL 7(0)

MAXIMUM RANGE CRUISE FUEL

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)

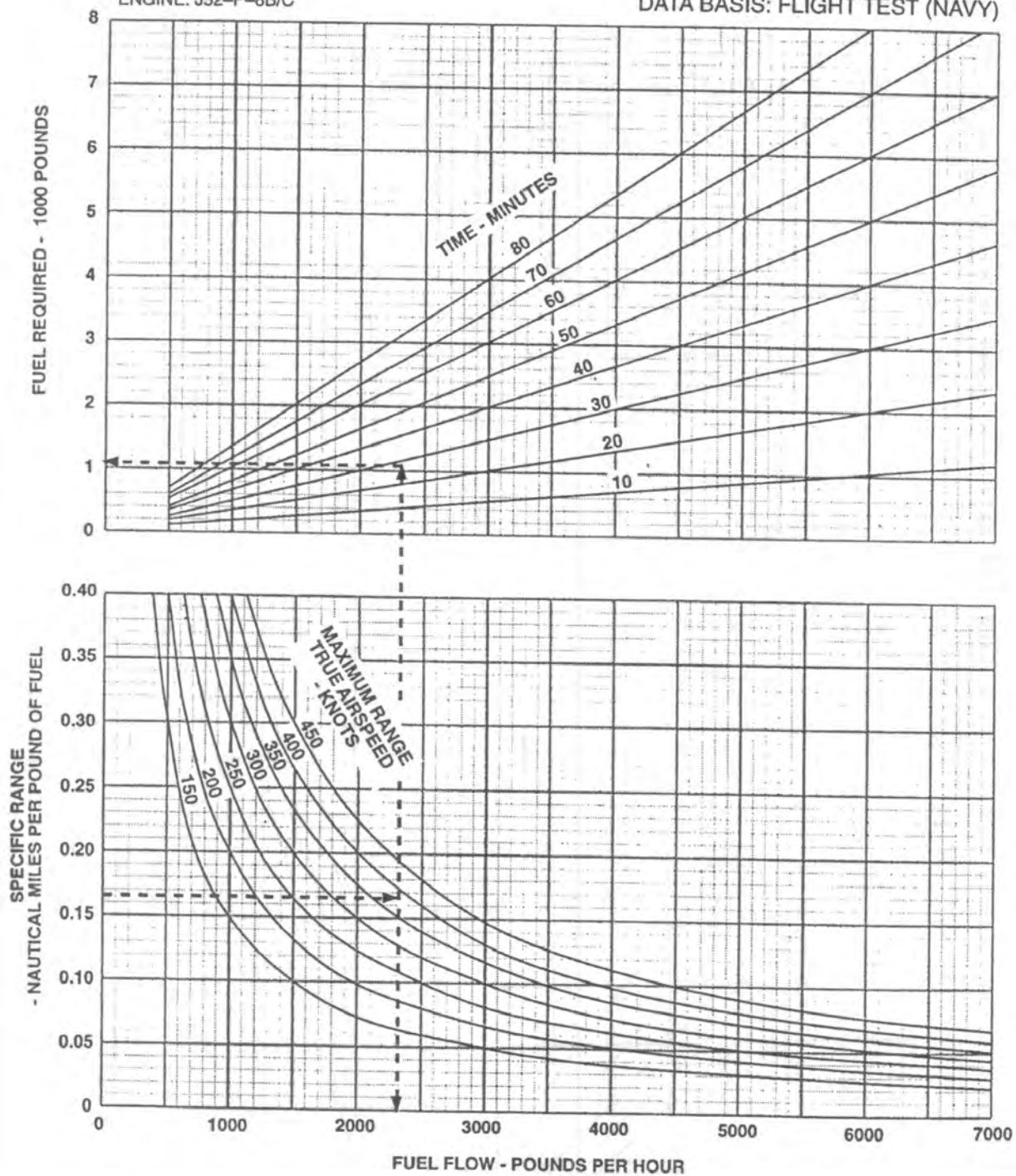


Figure 9-56 Maximum Range Cruise - Fuel A-4 (Sheet 2 of 3)

AL 7(0)

MAXIMUM RANGE CRUISE FUEL

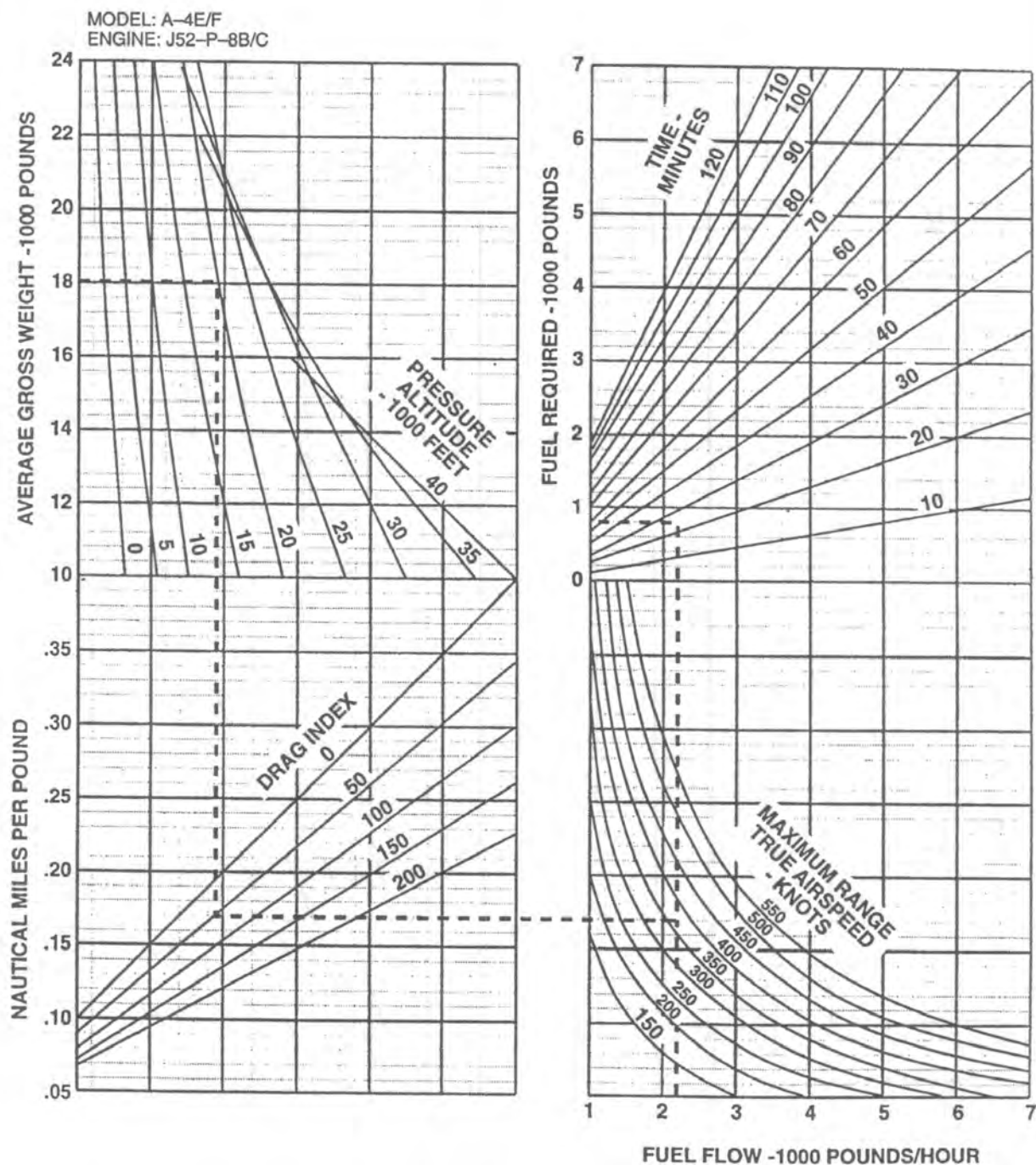


Figure 9-56 Maximum Range Cruise - Fuel A-4 (Sheet 3 of 3)

AL 7(0)

MAXIMUM RANGE CRUISE NAUTICAL MILES PER POUND OF FUEL

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

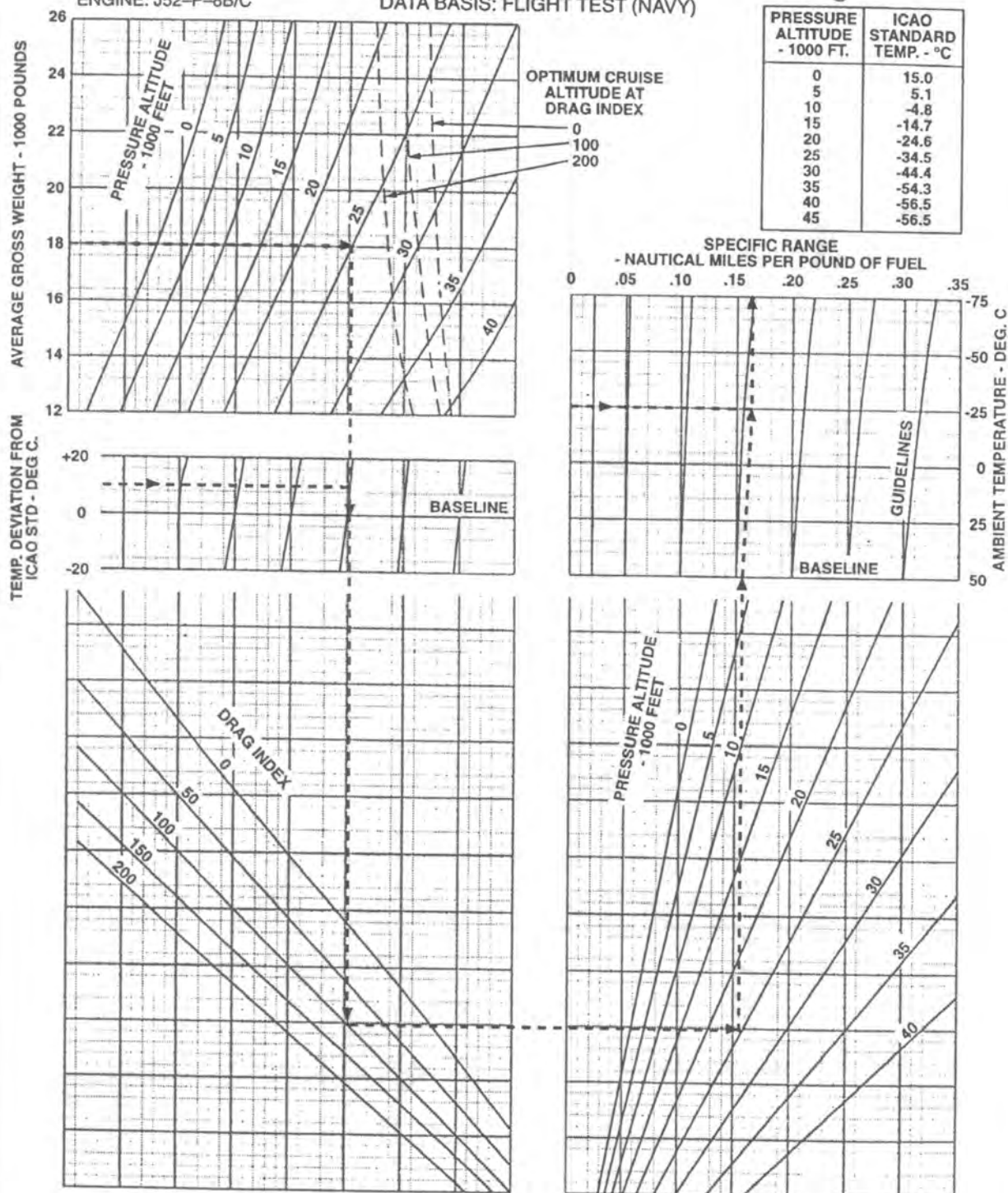


Figure 9-57 Maximum Range Cruise - Fuel TA-4 (Sheet 1 of 2)

AL 7(0)

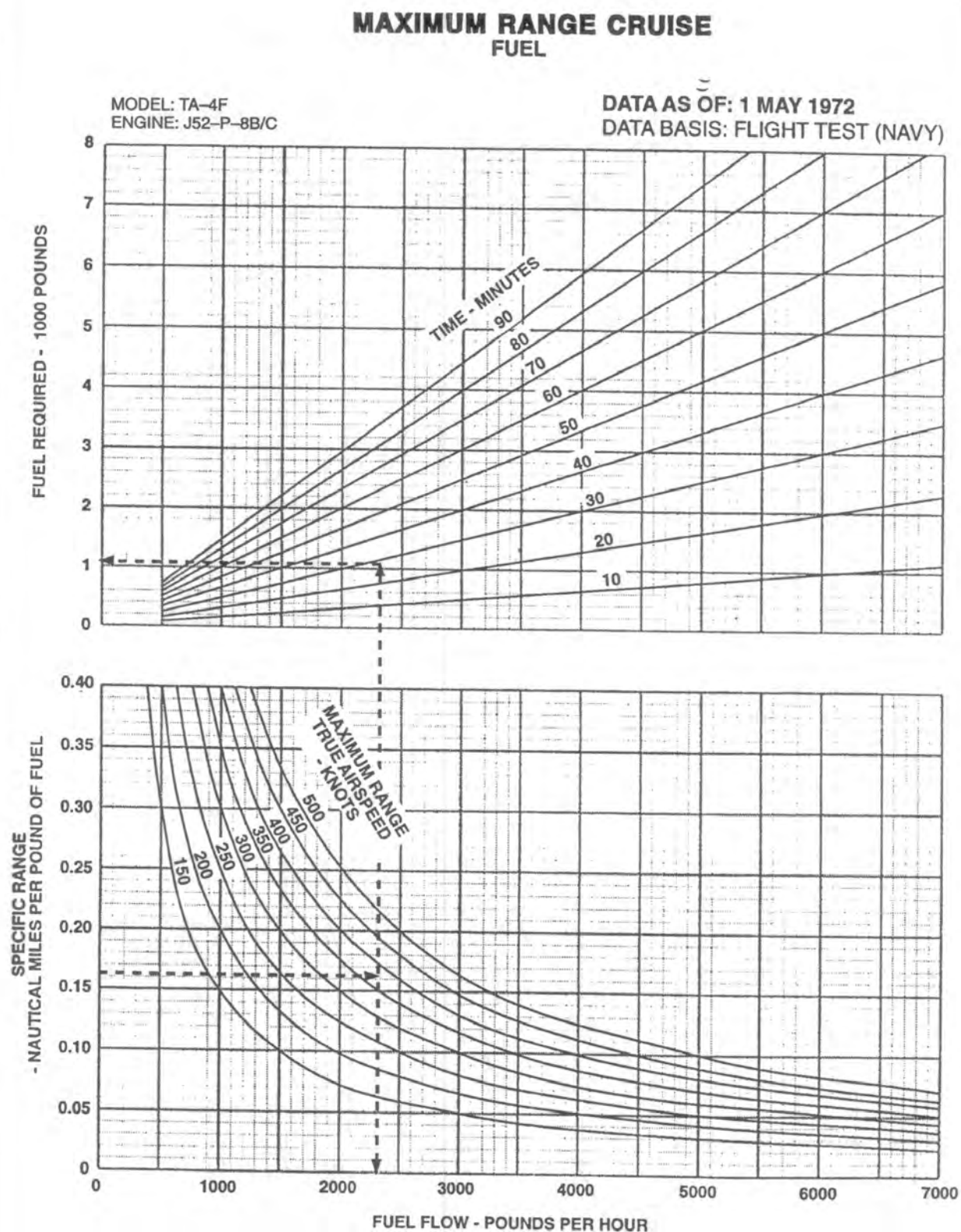


Figure 9-57 Maximum Range Cruise – Fuel TA-4 (Sheet 2 of 2)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL **CLEAN AIRCRAFT THRUST REQUIRED**

MODEL: A-4E/F
 ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
 DATA BASIS: FLIGHT TEST (NAVY)

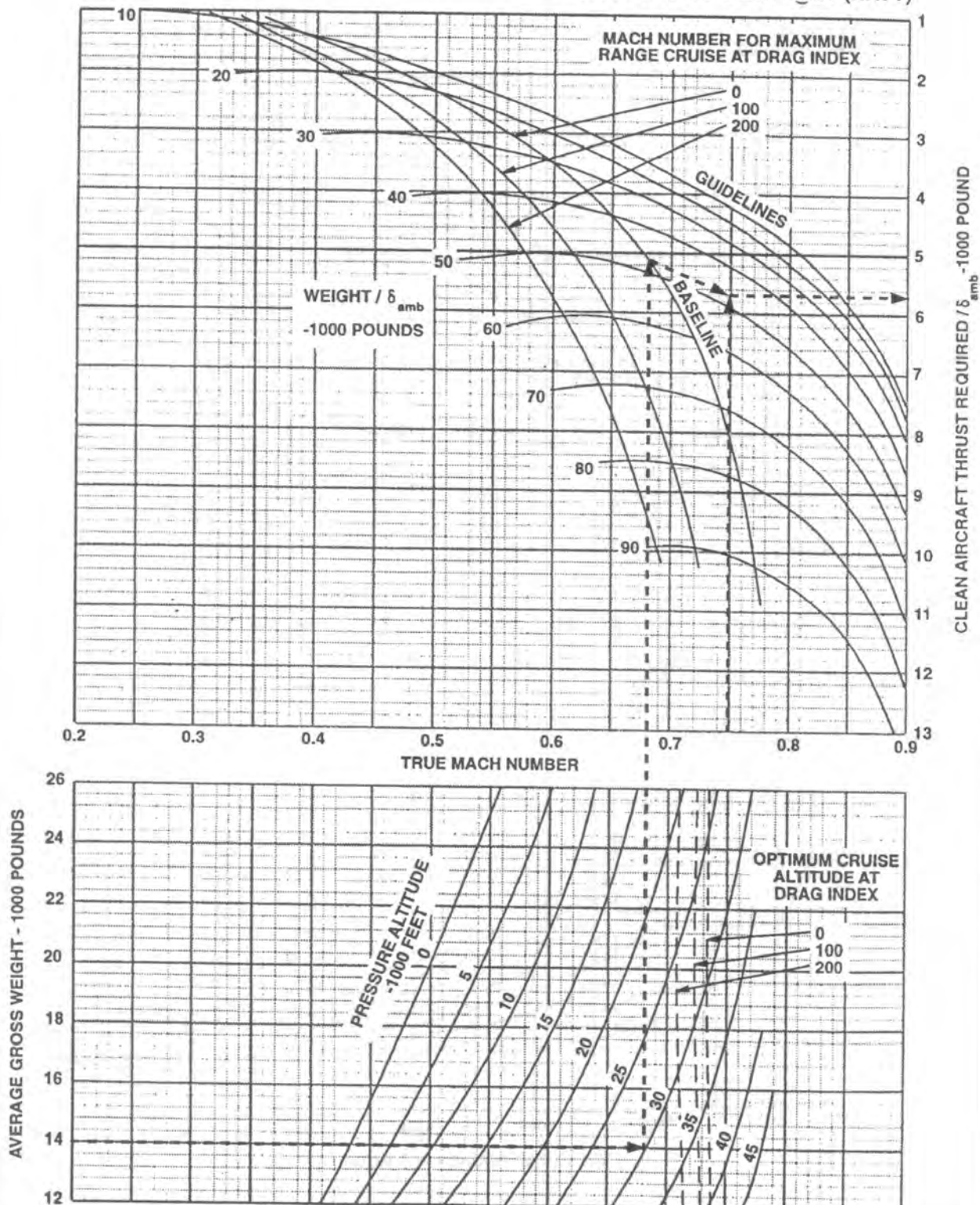


Figure 9-58 Nautical Miles Per Pound Of Fuel A-4 (Sheet 1 of 6)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL TOTAL THRUST REQUIRED

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)

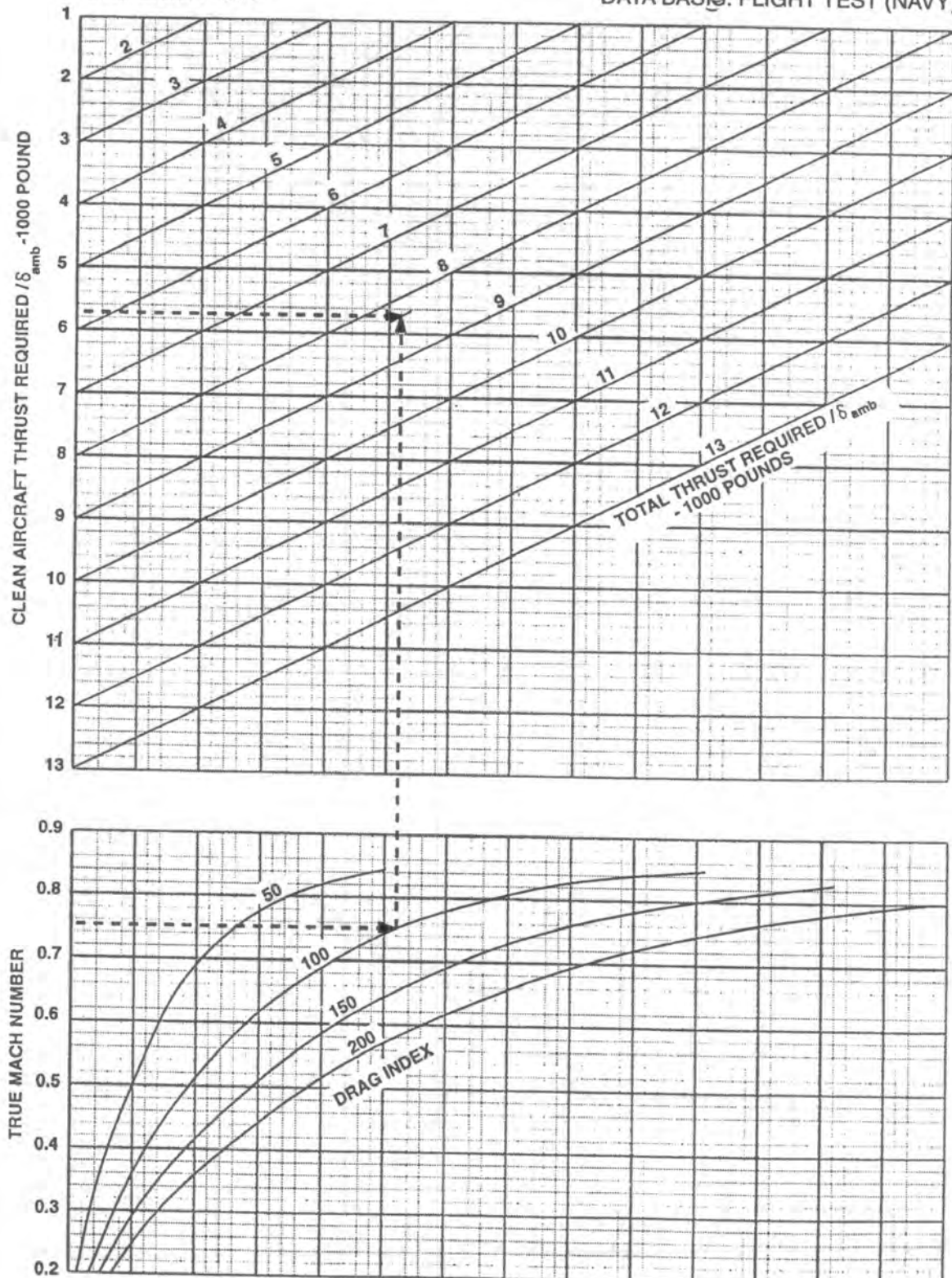


Figure 9-58 Nautical Miles Per Pound Of Fuel A-4 (Sheet 2 of 6)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL **REYNOLDS NUMBER INDEX**

MODEL: A-4E/F
 ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
 DATA BASIS: FLIGHT TEST (NAVY)

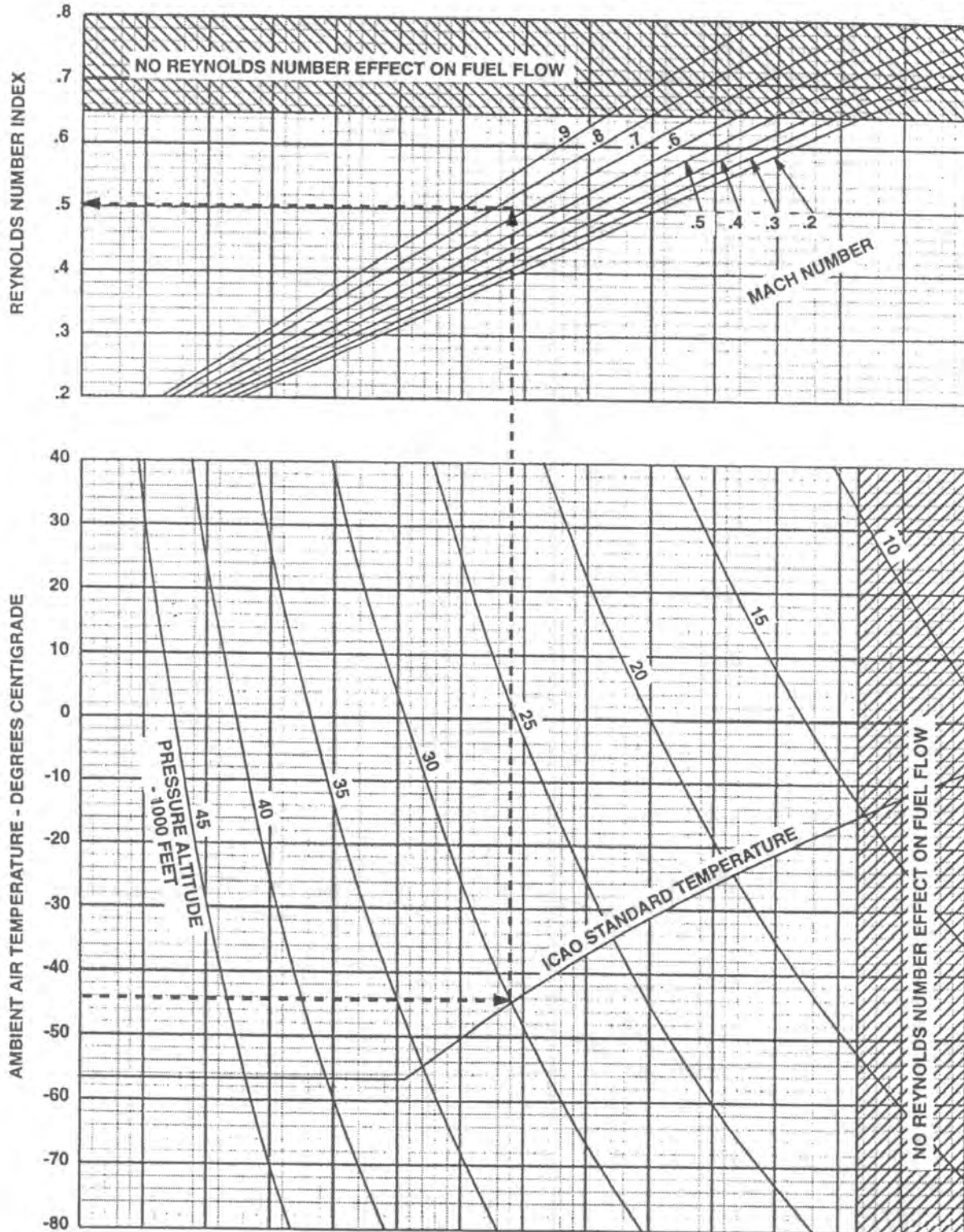


Figure 9-58 Nautical Miles Per Pound Of Fuel A-4 (Sheet 3 of 6)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL GENERAL FUEL FLOW PARAMETER

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)

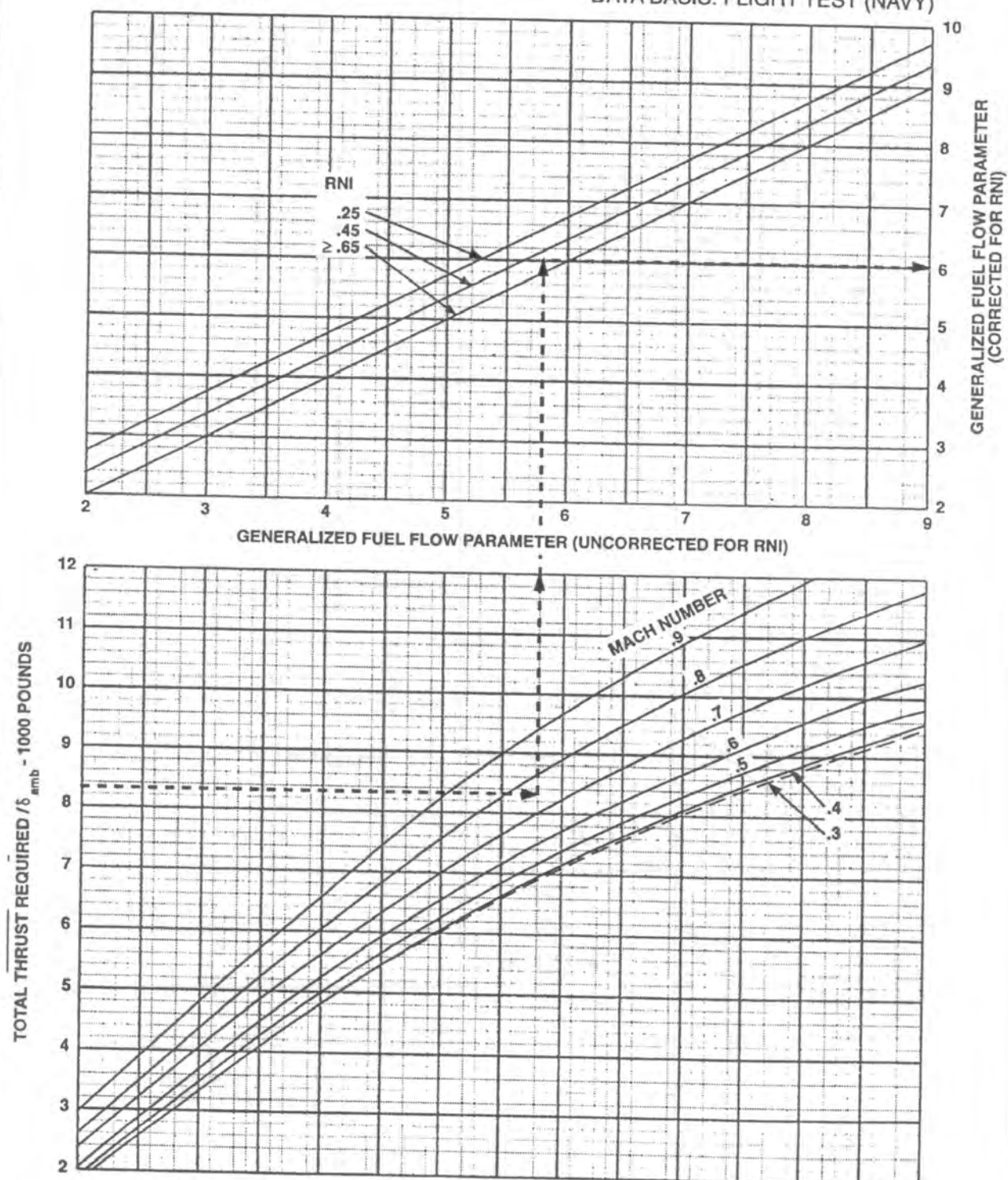


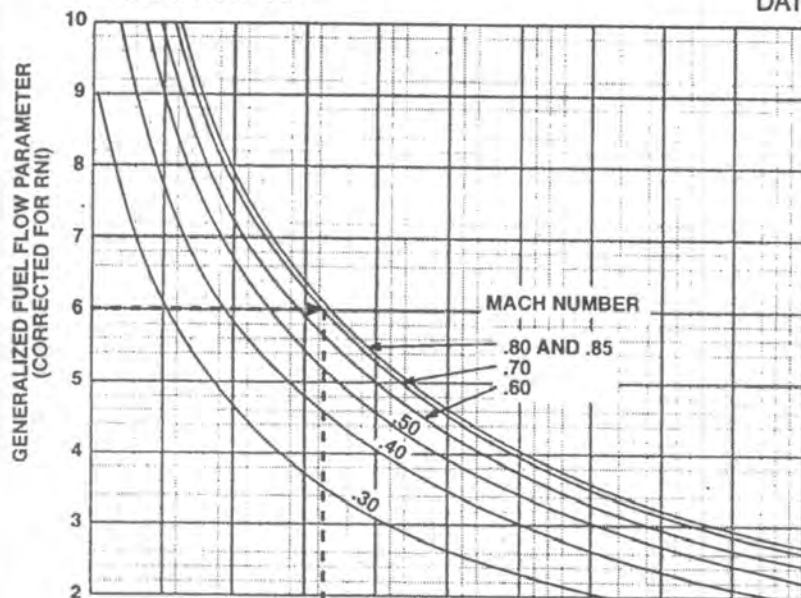
Figure 9-58 Nautical Miles Per Pound Of Fuel A-4 (Sheet 4 of 6)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)



PRESSURE ALTITUDE - 1000 FT.	ICAO STANDARD TEMP. - °C
0	15.0
5	5.1
10	-4.8
15	-14.7
20	-24.6
25	-34.5
30	-44.4
35	-54.3
40	-56.5
45	-56.5

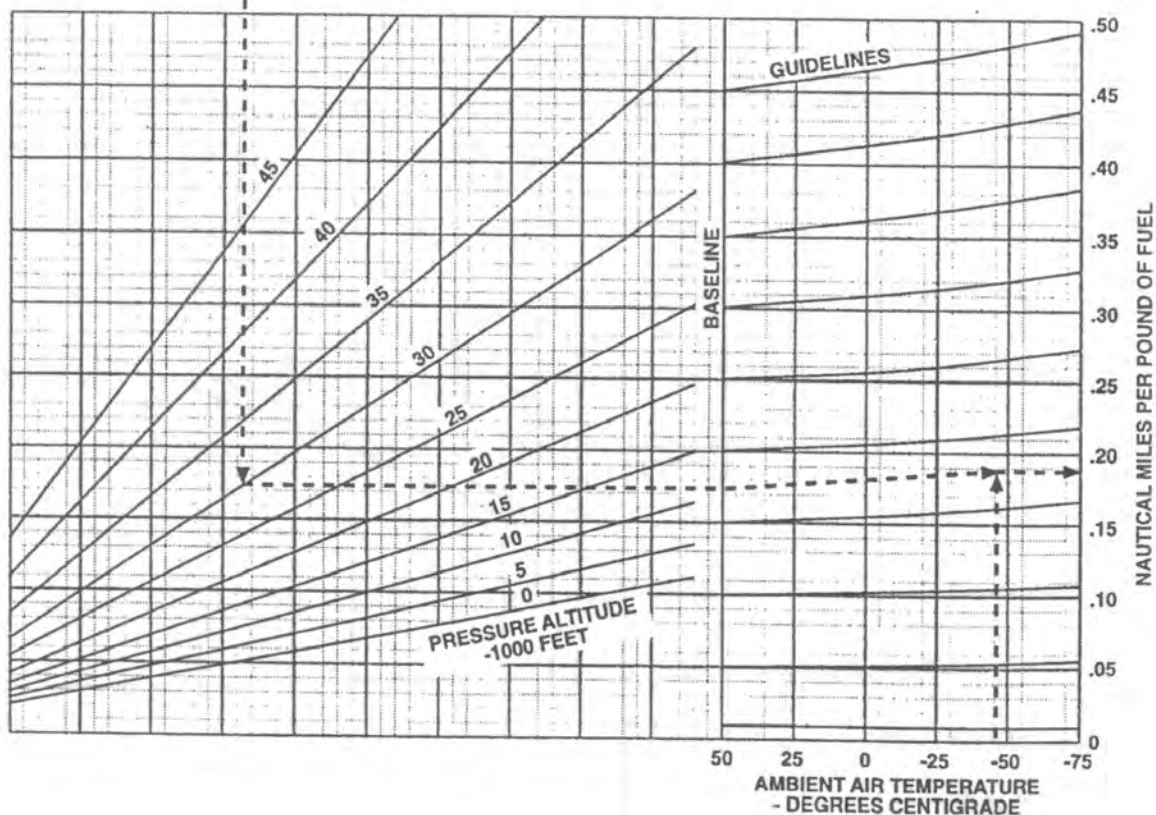


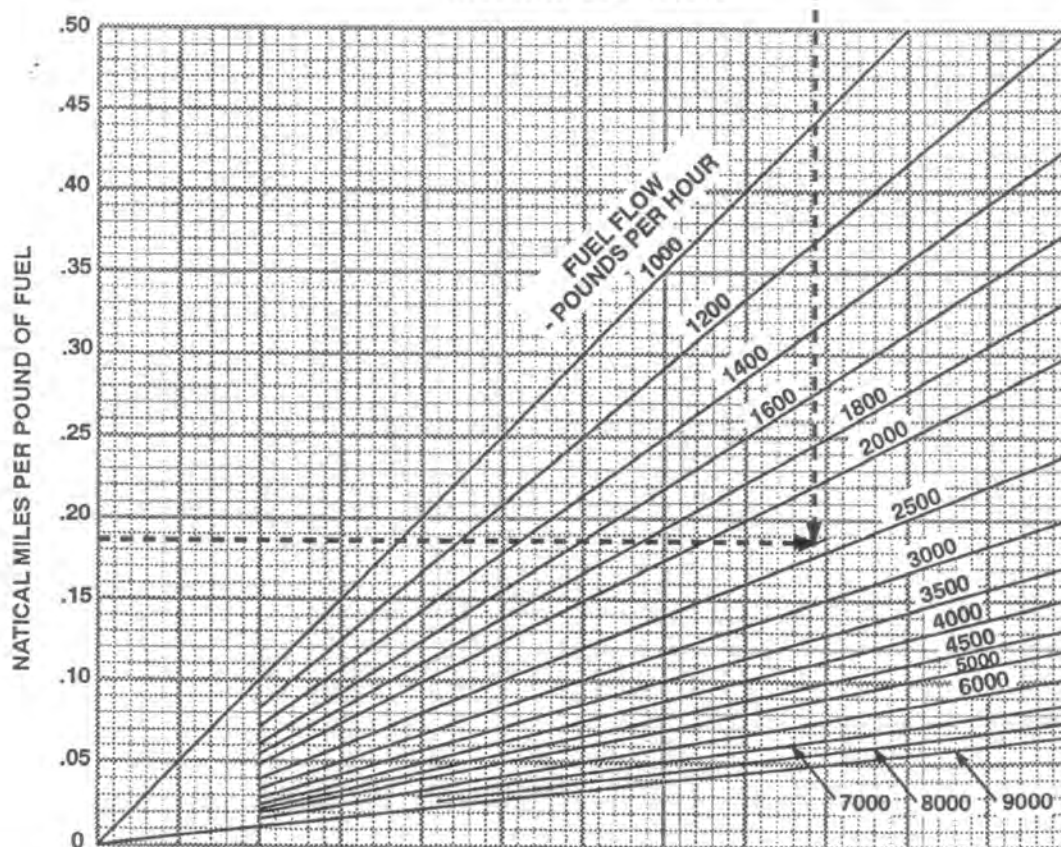
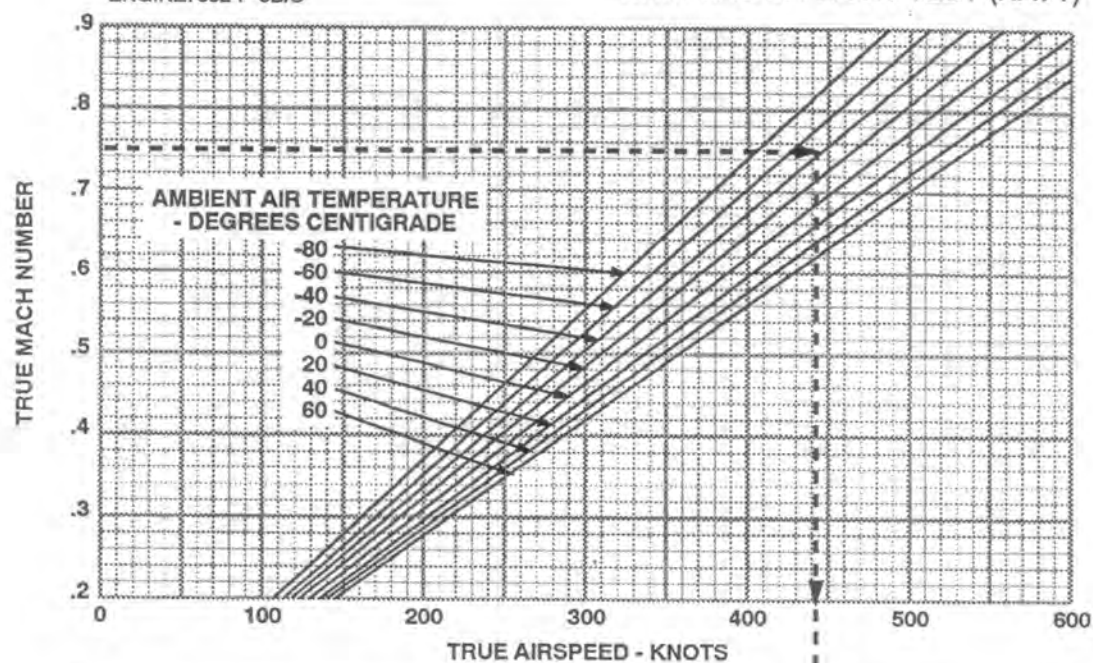
Figure 9-58 Nautical Miles Per Pound Of Fuel A-4 (Sheet 5 of 6)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL FUEL FLOW

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1729

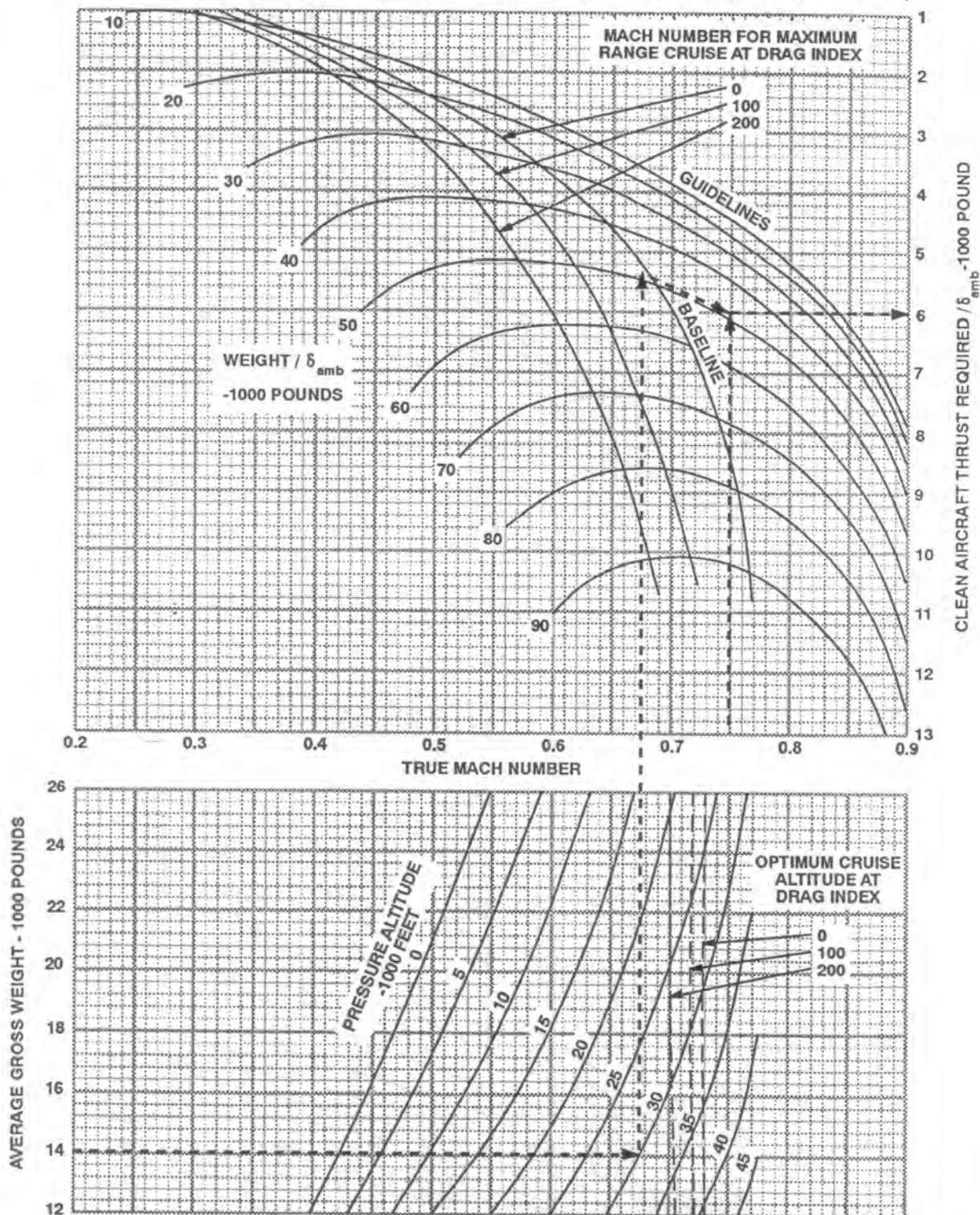
Figure 9-58 Nautical Miles Per Pound Of Fuel A-4 (Sheet 6 of 6)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL CLEAN AIRCRAFT THRUST REQUIRED

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1736

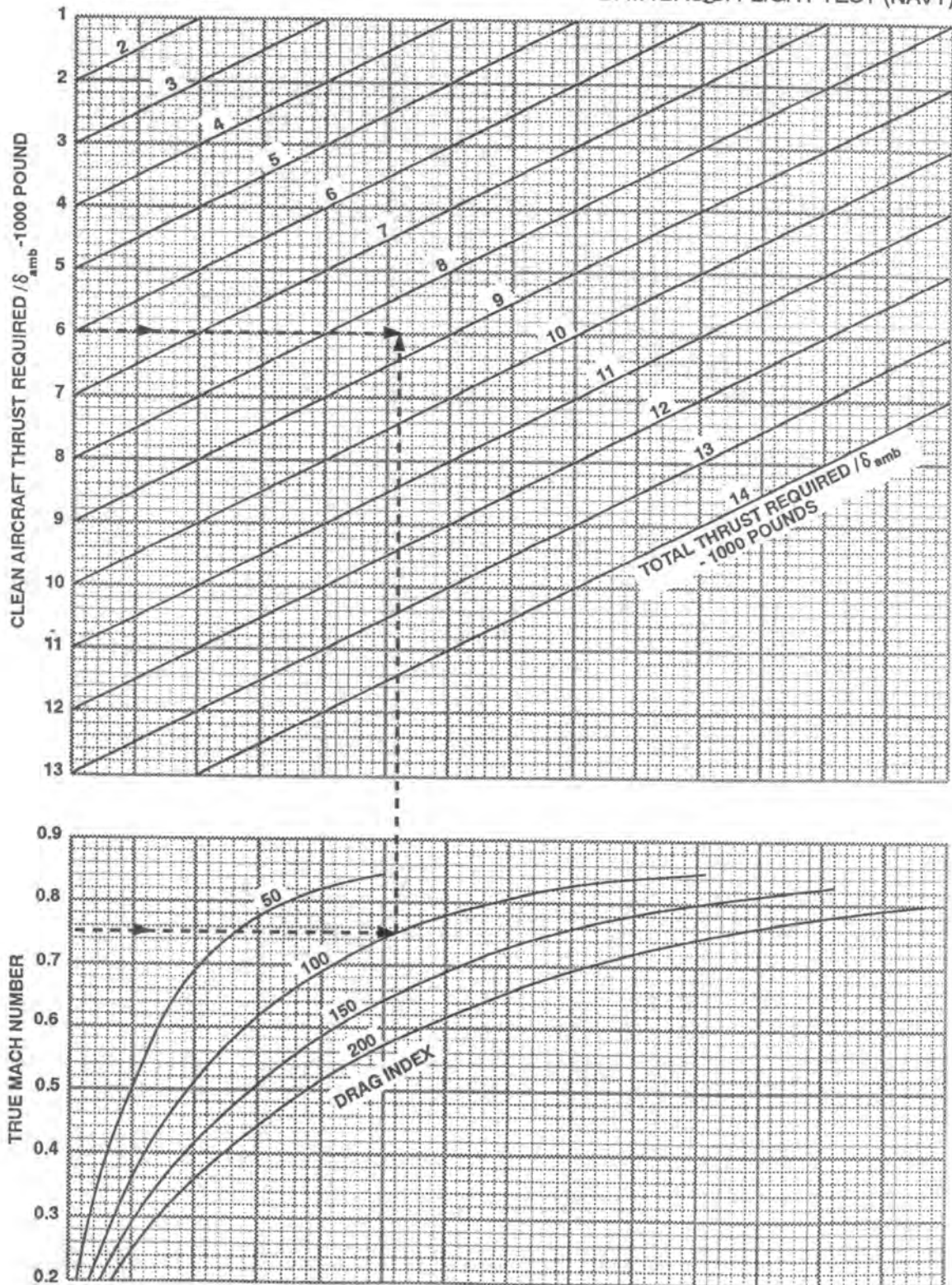
Figure 9-59 Nautical Miles Per Pound Of Fuel TA-4 (Sheet 1 of 6)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL TOTAL THRUST REQUIRED

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1737

Figure 9-59 Nautical Miles Per Pound Of Fuel TA-4 (Sheet 2 of 6)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL **REYNOLDS NUMBER INDEX**

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

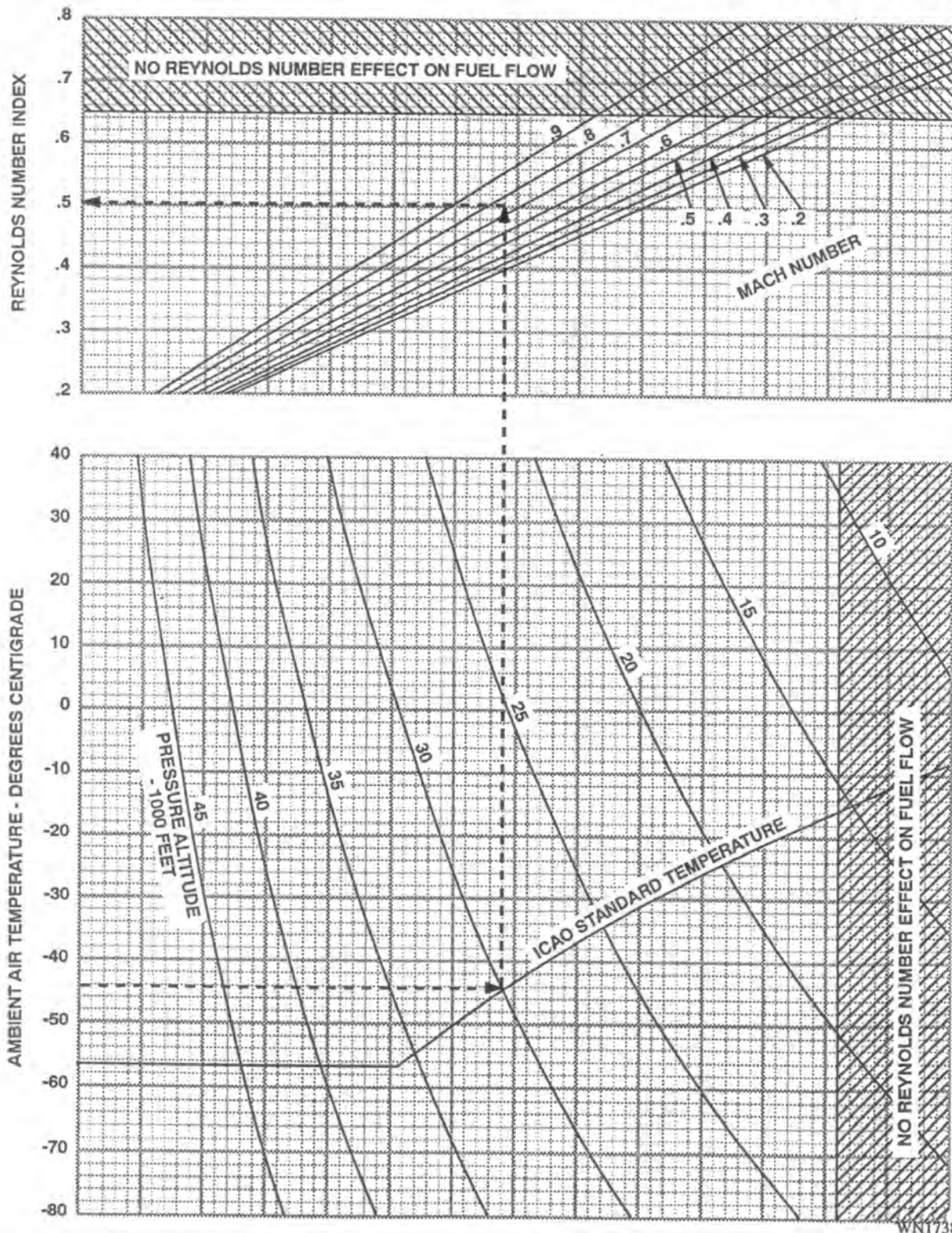


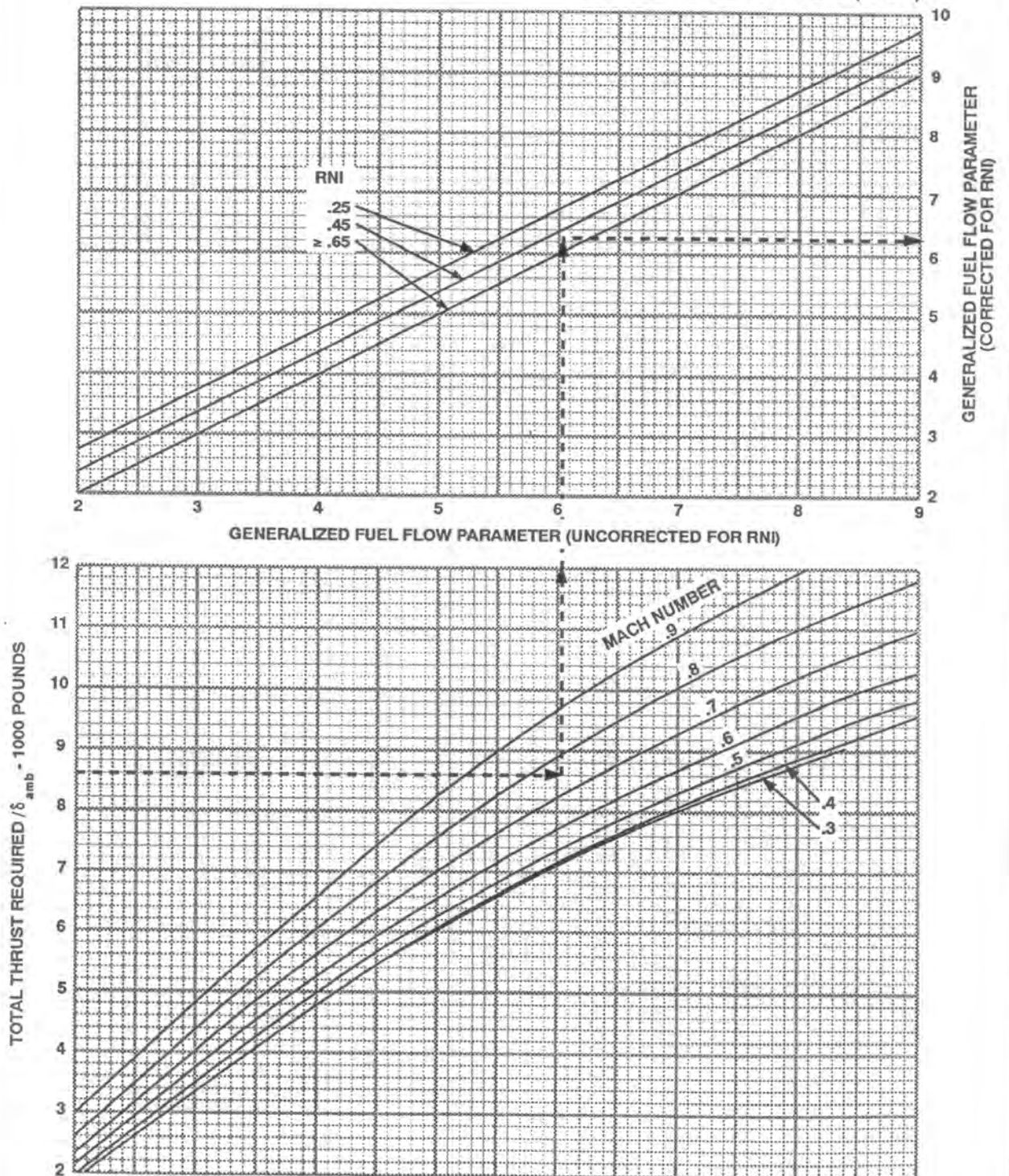
Figure 9-59 Nautical Miles Per Pound Of Fuel TA-4 (Sheet 3 of 6)

AL 7(0)

NAUTICAL MILES PER POUND OF FUEL GENERALIZED FUEL FLOW PARAMETER

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1739

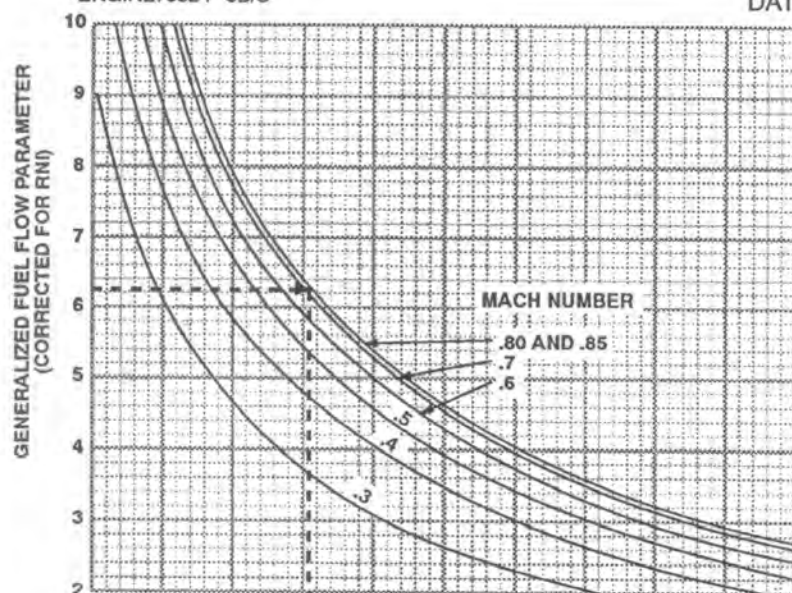
Figure 9-59 Nautical Miles Per Pound Of Fuel TA-4 (Sheet 4 of 6)

AL 7(0)

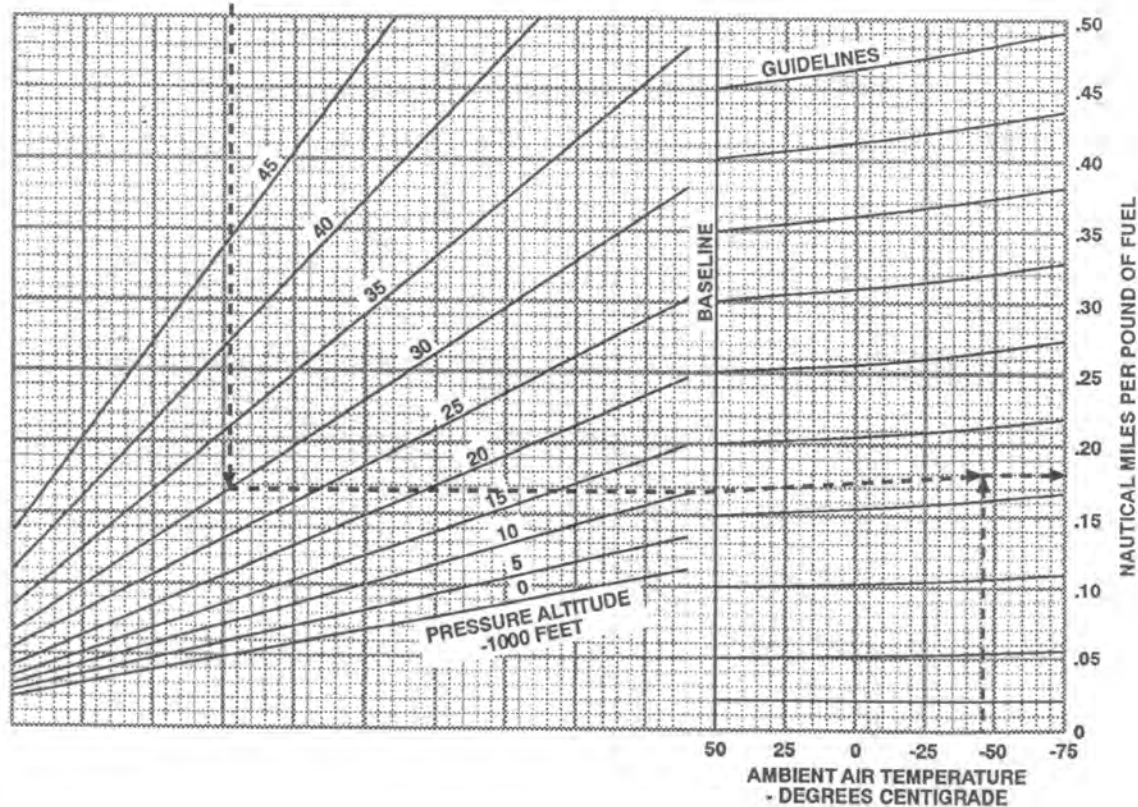
NAUTICAL MILES PER POUND OF FUEL

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



PRESSURE ALTITUDE - 1000 FT.	ICAO STANDARD TEMP. - °C
0	15.0
5	5.1
10	-4.8
15	-14.7
20	-24.6
25	-34.5
30	-44.4
35	-54.3
40	-56.5
45	-56.5



WN1740

Figure 9-59 Nautical Miles Per Pound Of Fuel TA-4 (Sheet 5 of 6)

AL 7(0)

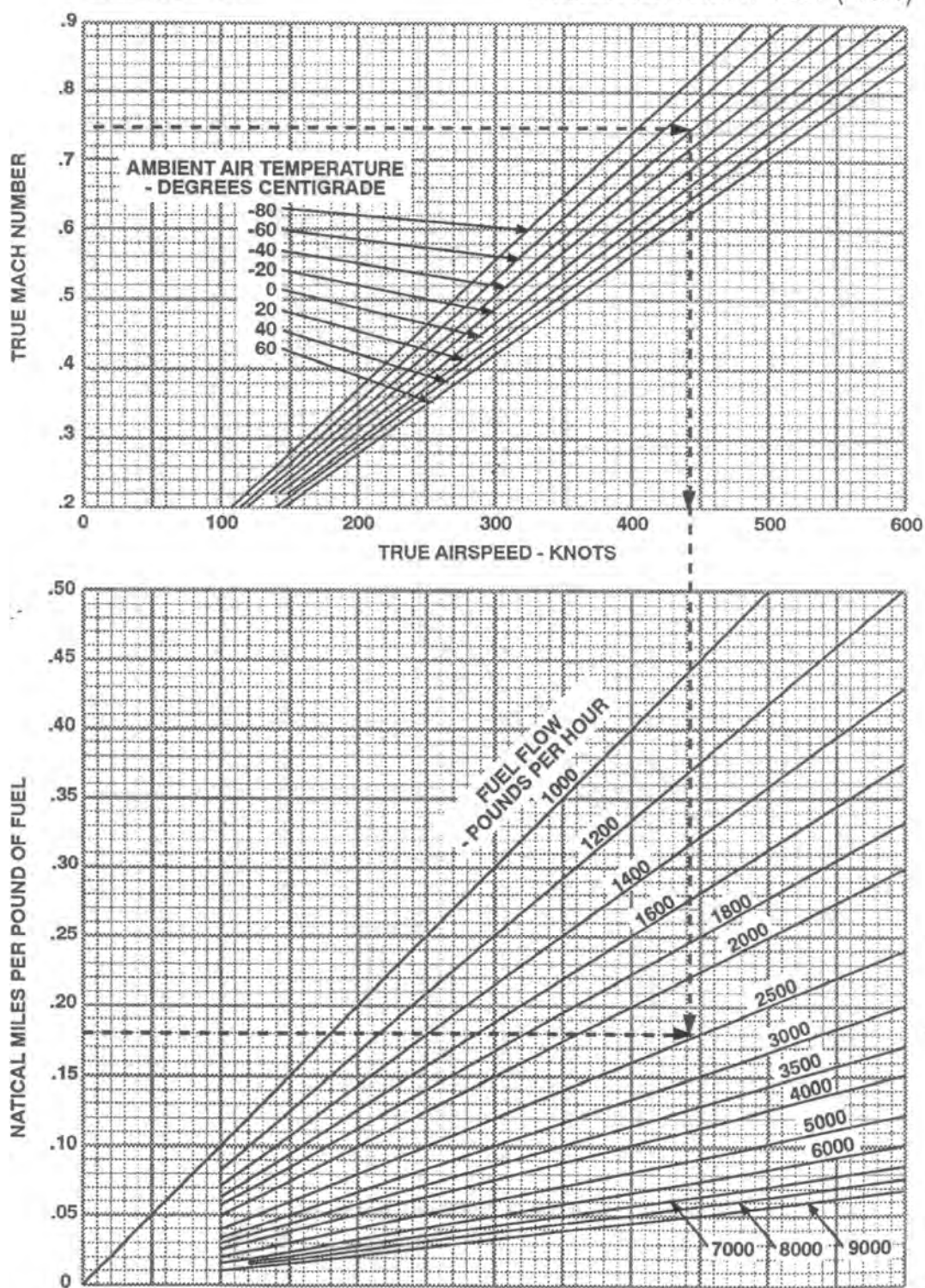
NAUTICAL MILES PER POUND OF FUEL FUEL FLOW

MODEL: TA-4F

ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972

DATA BASIS: FLIGHT TEST (NAVY)



WN1741

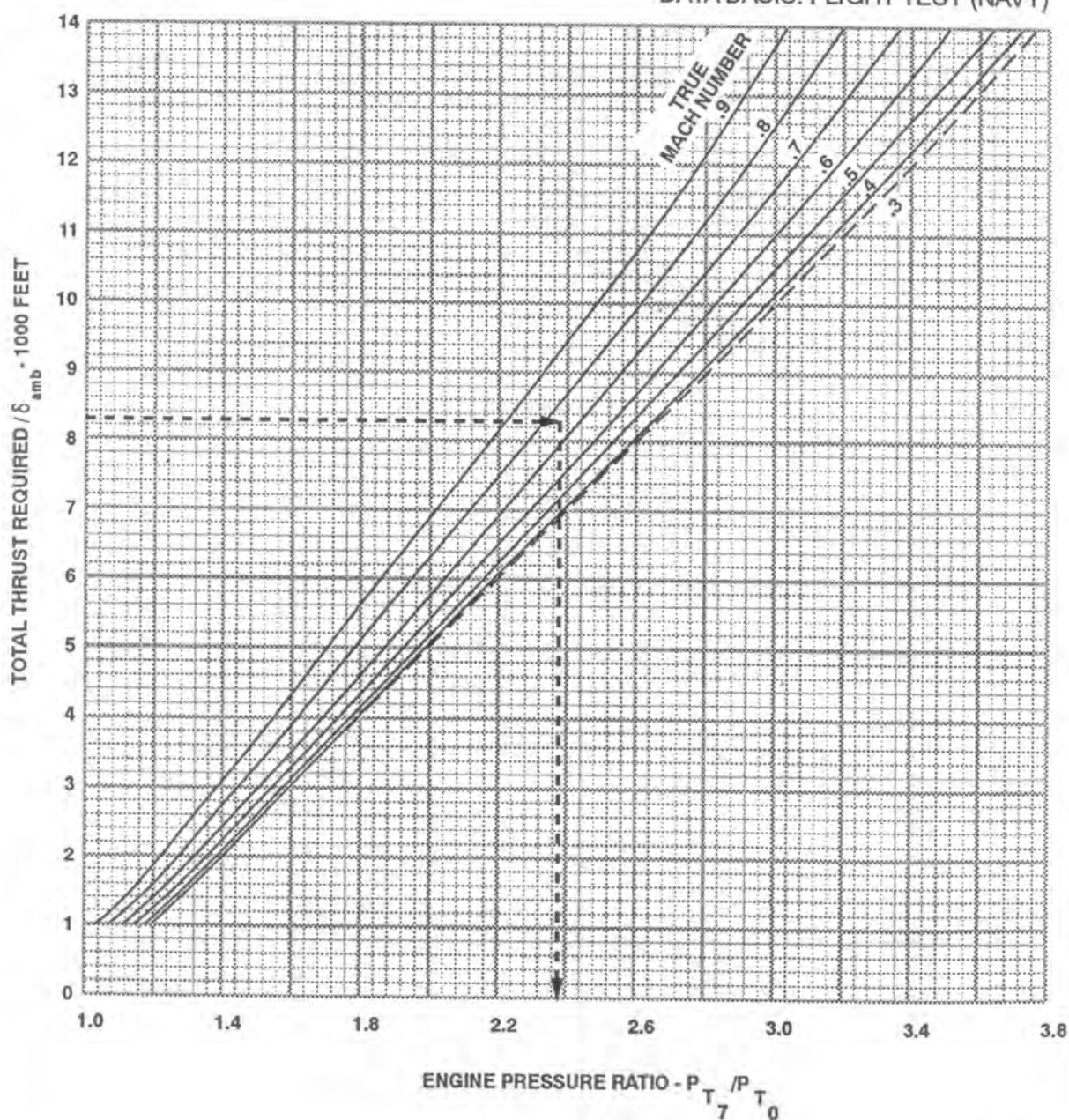
Figure 9-59 Nautical Miles Per Pound Of Fuel TA-4 (Sheet 6 of 6)

AL 7(0)

ENGINE PRESSURE RATIO FOR CRUISE

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1730

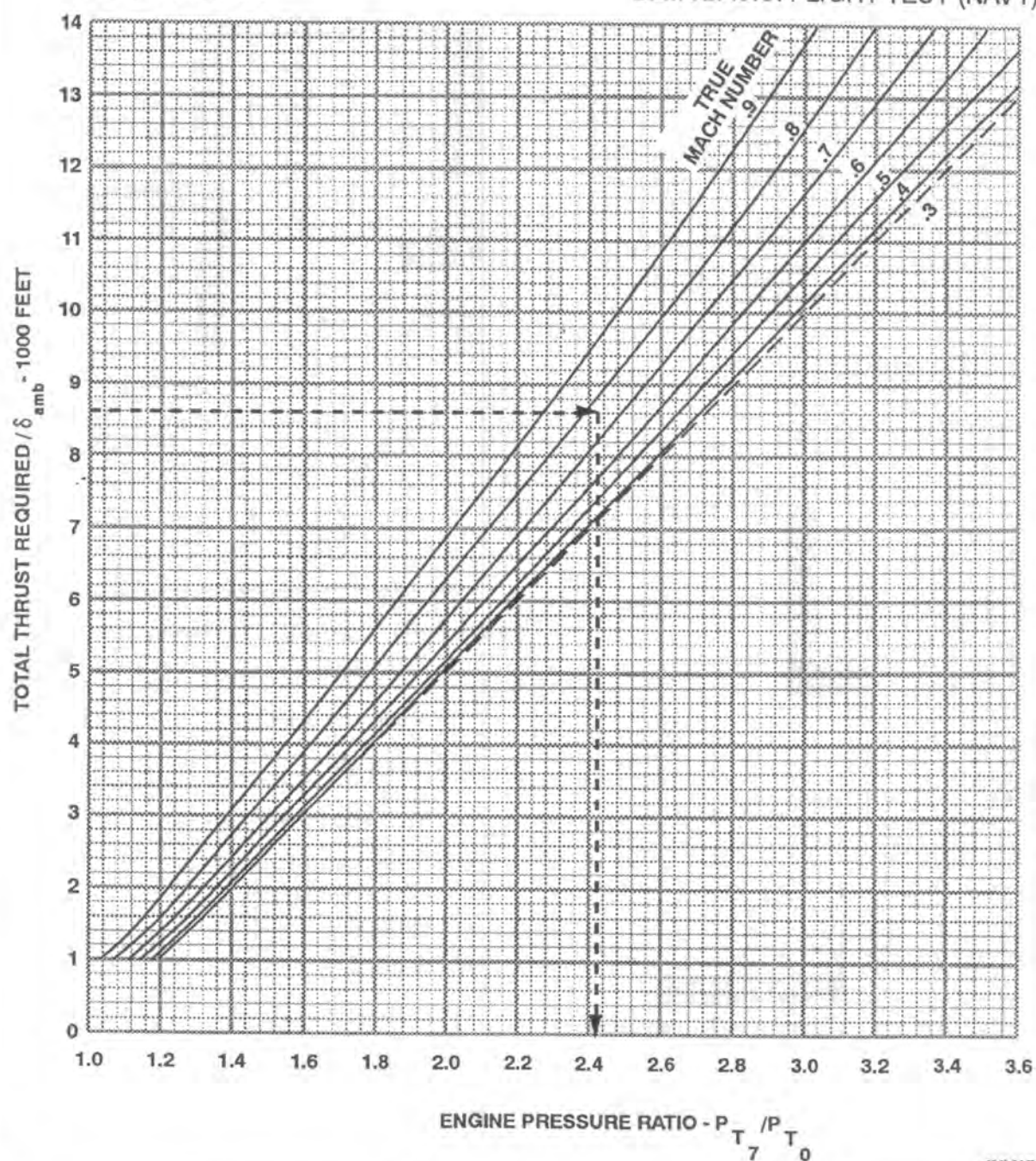
Figure 9-60 Engine Pressure Ratio For Cruise A-4

AL 7(0)

ENGINE PRESSURE RATIO FOR CRUISE

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1742

Figure 9-61 Engine Pressure Ratio for Cruise TA-4

ENDURANCE

BINGO ENDURANCE

9.47 Bingo Endurance charts are provided for an aircraft configuration consisting of four wing pylons, guns, and two 300-gallon external fuel tanks.

9.48 An 800-pound fuel allowance is included for approach and landing.

MAXIMUM ENDURANCE

9.49 The maximum endurance charts (Figure 9-65 to Figure 9-68) provide a means of determining the Mach number and calibrated airspeed for maximum endurance with the associated fuel flow and fuel required for a specific loiter time. These data are provided for a constant altitude loiter condition. Optimum loiter altitude lines, altitude for best endurance, are superimposed on the pressure altitude plots. To use these charts, the average gross weight, bank angle, pressure altitude, drag index, ambient air temperature, and loiter time must be known. The charts then provide Mach number, calibrated airspeed, fuel flow, and fuel required for maximum endurance.

SAMPLE PROBLEM

Maximum Endurance Speed

(For Figure 9-65)

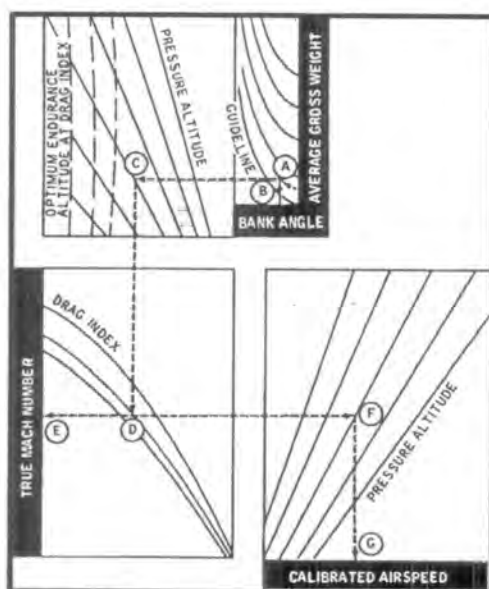


Figure 9-62 Sample Maximum Endurance Speed

- (A) Average gross weight 15,000 lb
- (B) Bank angle 15 degrees
- (C) Loiter pressure altitude 25,000 ft

- (D) Drag index 100
- (E) Mach number for maximum endurance 0.477
- (F) Loiter pressure altitude 25,000 ft
- (G) Loiter airspeed 196 KCAS

SAMPLE PROBLEM

Maximum Endurance Fuel

(For Figure 9-66)

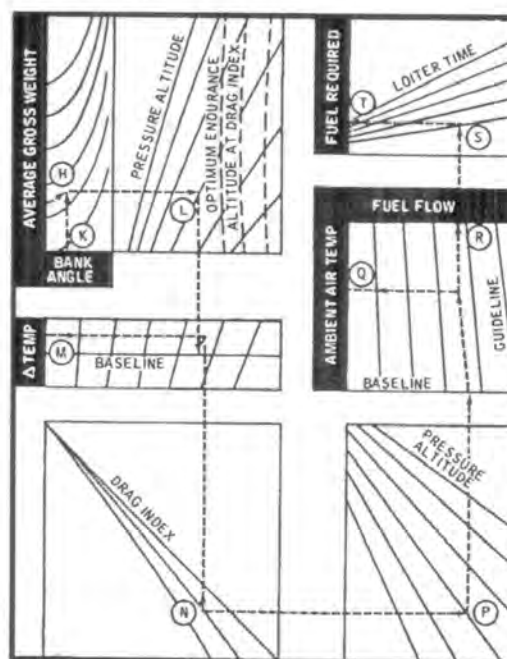


Figure 9-63 Sample Maximum Endurance Fuel

- (H) Average gross weight 15,000 lb
- (K) Bank angle 15 degrees
- (L) Loiter pressure altitude 25,000 ft
- (M) Temperature deviation from ICAO standard (Ambient temperature = -24.5°C) +10°C
- (N) Drag index 100
- (P) Loiter pressure altitude 25,000 ft
- (Q) Ambient air temperature -24.5°C
- (R) Fuel flow 1780 lb/hr
- (S) Loiter time 30 min
- (T) Fuel required 890 lb

BINGO ENDURANCE

Drag Index = 73

Aircraft Weight (Less Fuel) = 12,116 Pounds

All Pylons, Guns (No Ammo), and Two 300 Gallon External Tanks

Reserve Fuel for Landing = 800 Pounds

Model: A-4F

Engine: J52-P-8A/B

Data as of: 15 November 1972

Data Basis: Flight Test (Navy)

FUEL BOARD POSITIONS	IF YOU ARE AT SEA LEVEL			IF YOU ARE AT 10,000 FEET			IF YOU ARE AT 20,000 FEET			
	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	
	SEA LEVEL	OPTIMUM ALTITUDE		10, 000 FEET	OPTIMUM ALTITUDE		20,000 FEET	OPTIMUM ALTITUDE		
	Minutes	Minutes	Feet	Minutes	Minutes	Feet	Minutes	Minutes	Feet	
	2700	58	74	35,000	69	78	35,000	80	82	35,000
	2500	52	67	35,000	63	71	35,000	73	75	35,000
	2300	46	59	35,000	56	63	35,000	66	67	35,000
	2100	40	51	35,000	49	55	35,000	58	59	35,000
	1900	34	43	30,000	42	47	30,000	50	51	30,000
	1700	28	35	30,000	35	39	30,000	42	43	30,000
1500	22	27	25,000	28	31	25,000	34	35	30,000	
1300	16	19	20,000	21	23	25,000	26	27	25,000	
1100	10	12	5,000	14	15	15,000	18	18	20,000	
	IF YOU ARE AT 30,000 FEET			IF YOU ARE AT 35,000 FEET			IF YOU ARE AT 40,000 FEET			
	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	
	30,000 FEET	OPTIMUM ALTITUDE		35, 000 FEET	OPTIMUM ALTITUDE		40,000 FEET	OPTIMUM ALTITUDE		
	Minutes	Minutes	Feet	Minutes	Minutes	Feet	Minutes	Minutes	Feet	
	2700	87	87	30,000	87	87	35,000	82	89	35,000
	2500	79	79	30,000	80	80	35,000	76	81	35,000
	2300	71	71	30,000	72	72	35,000	69	73	35,000
	2100	63	63	30,000	64	64	35,000	62	66	35,000
	1900	55	55	30,000	56	56	35,000	54	58	35,000
	1700	47	47	30,000	48	48	35,000	47	49	35,000
1500	38	38	30,000	40	40	35,000	39	41	40,000	
1300	30	30	30,000	31	31	35,000	32	33	40,000	
1100	22	22	30,000	23	23	35,000	24	24	40,000	

PRESSURE ALTITUDE	CLIMB SPEED MILITARY THRUST		ENDURANCE SPEED	DESCENT SPEED ENGINE IDLE SPEEDBRAKES CLOSED	START LETDOWN FROM ALTITUDE WITH FUEL REMAINING
Feet	KCAS	Mach No.	KCAS	KCAS	Pounds
Sea Level	320		185	185	800
5,000	320		185	185	823
10,000	320		185	185	840
15,000	320		185	185	855
20,000	320		185	185	869
25,000		0.706	185	185	882
30,000		0.706	190	185	895
35,000		0.706	190	185	907
40,000		0.706	185	185	919

Figure 9-64 Bingo Endurance (Sheet 1 of 2)

BINGO ENDURANCE

Drag Index = 61

Aircraft Weight (Less Fuel) = 12, 816 Pounds

All Pylons, Guns (No Ammo), and Two 300 Gallon External Tanks

Reserve Fuel for Landing = 800 Pounds

Model: TA-4F

Engine: J52-P-8A/B

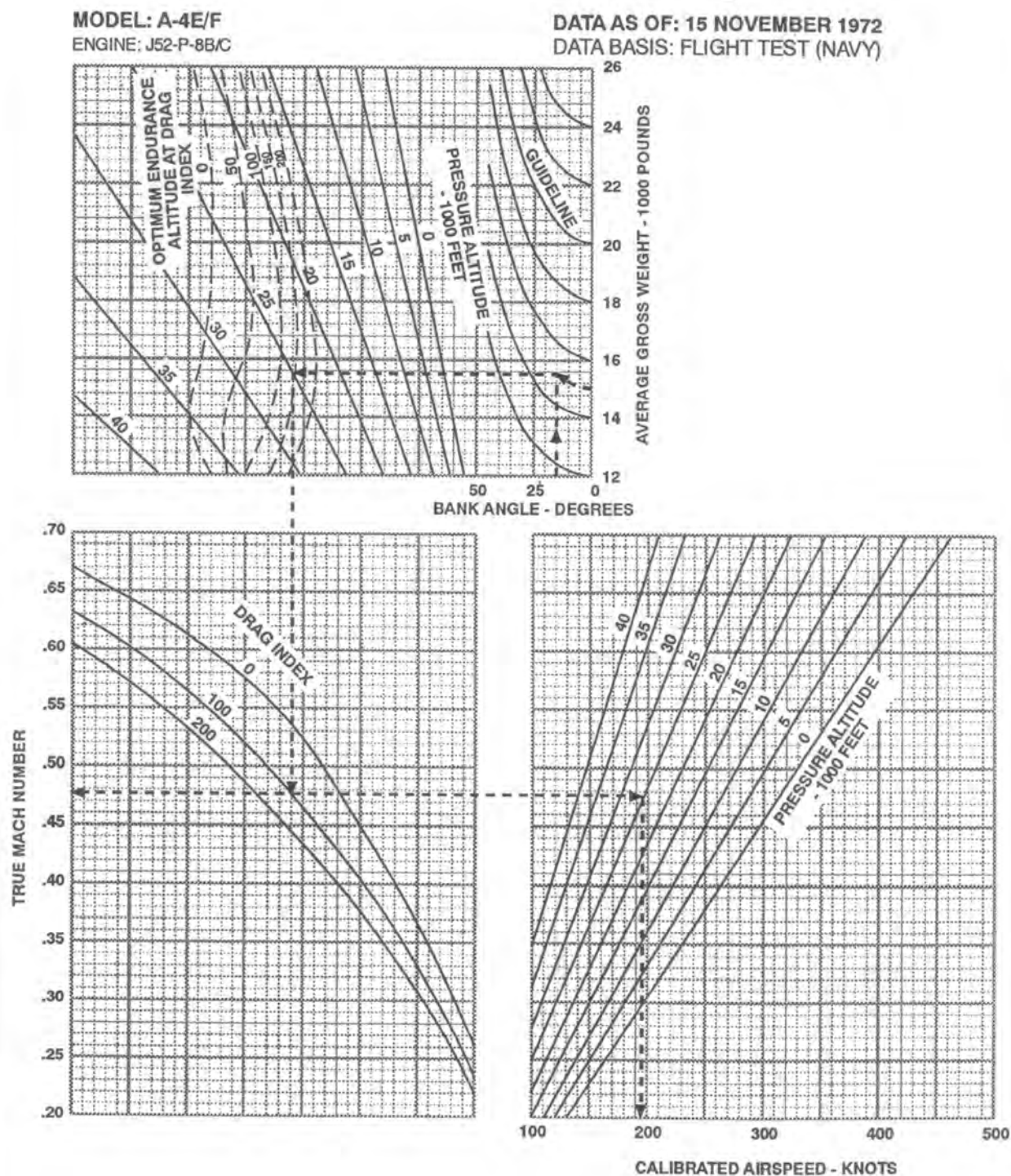
Data as of: 1 MAY 1972

Data Basis: FLIGHT TEST (NAVY)

FUEL BOARD POUNDS	IF YOU ARE AT SEA LEVEL			IF YOU ARE AT 10,000 FEET			IF YOU ARE AT 20,000 FEET			
	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	
	SEA LEVEL	OPTIMUM ALTITUDE		10, 000 FEET	OPTIMUM ALTITUDE		20,000 FEET	OPTIMUM ALTITUDE		
	Minutes	Minutes	Feet	Minutes	Minutes	Feet	Minutes	Minutes	Feet	
	2700	56	72	30,000	68	75	30,000	78	79	30,000
	2500	50	64	30,000	61	68	30,000	71	72	30,000
	2300	45	57	30, 000	55	61	30,000	64	65	30,000
	2100	39	49	30,000	48	53	30,000	56	57	30,000
	1900	33	42	30,000	41	45	30,000	49	49	30,000
	1700	27	34	30,000	35	38	30,000	41	42	30,000
1500	21	26	30,000	28	30	30,000	34	34	30,000	
1300	15	18	20,000	21	22	20,000	26	26	20,000	
1100	9	11	15,000	14	14	15,000	18	18	20,000	
	IF YOU ARE AT 30,000 FEET			IF YOU ARE AT 35,000 FEET			IF YOU ARE AT 40,000 FEET			
	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	ENDURANCE AT		OPTIMUM ENDURANCE ALTITUDE	
	30,000 FEET	OPTIMUM ALTITUDE		35, 000 FEET	OPTIMUM ALTITUDE		40,000 FEET	OPTIMUM ALTITUDE		
	Minutes	Minutes	Feet	Minutes	Minutes	Feet	Minutes	Minutes	Feet	
	2700	83	83	30, 000	83	84	30,000	77	85	30,000
	2500	75	75	30,000	76	77	30,000	71	78	30,000
	2300	68	68	30,000	69	69	30,000	67	70	30,000
	2100	60	60	30,000	61	62	30,000	58	63	30,000
	1900	53	53	30,000	54	54	30,000	51	55	30,000
	1700	45	45	30, 000	46	46	35,000	45	47	35,000
1500	37	37	30,000	38	38	35,000	38	40	35,000	
1300	29	29	30,000	30	30	35,000	30	32	35, 000	
1100	21	21	30, 000	22	23	35,000	23	24	35,000	
PRESSURE ALTITUDE		CLIMB SPEED MILITARY THRUST		ENDURANCE SPEED	DESCENT SPEED ENGINE IDLE SPEEDBRAKES CLOSED		START LETDOWN FROM ALTITUDE WITH FUEL TIME REMAINING			
Feet		KCAS	Mach No.	KCAS	KCAS		Pounds			
Sea Level		310		195	190		800/0			
5,000		310		195	190		823/2			
10,000		310		195	190		839/4			
15,000		310		195	190		853/6			
20,000		310		195	190		867/8			
25,000			0.71	195	190		880/10			
30,000			0.71	195	190		892/12			
35,000			0.71	195	190		904/14			
40,000			0.71	195	190		916/16			

Figure 9-64 Bingo Endurance Chart (Sheet 2 of 2)

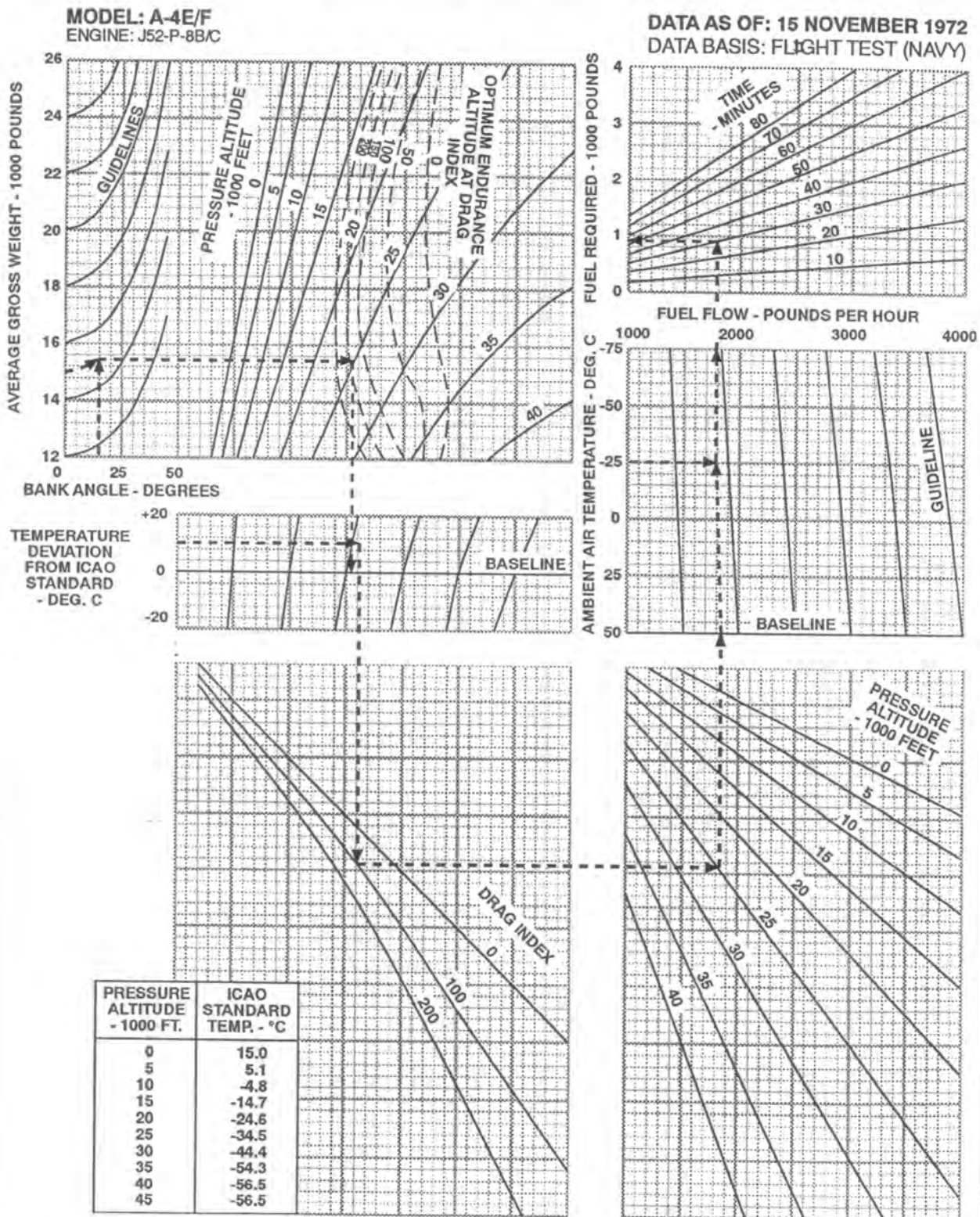
AL 7(0)

MAXIMUM ENDURANCE SPEED

WN1743

Figure 9-65 Maximum Endurance Speed A-4

MAXIMUM ENDURANCE FUEL



WN1744

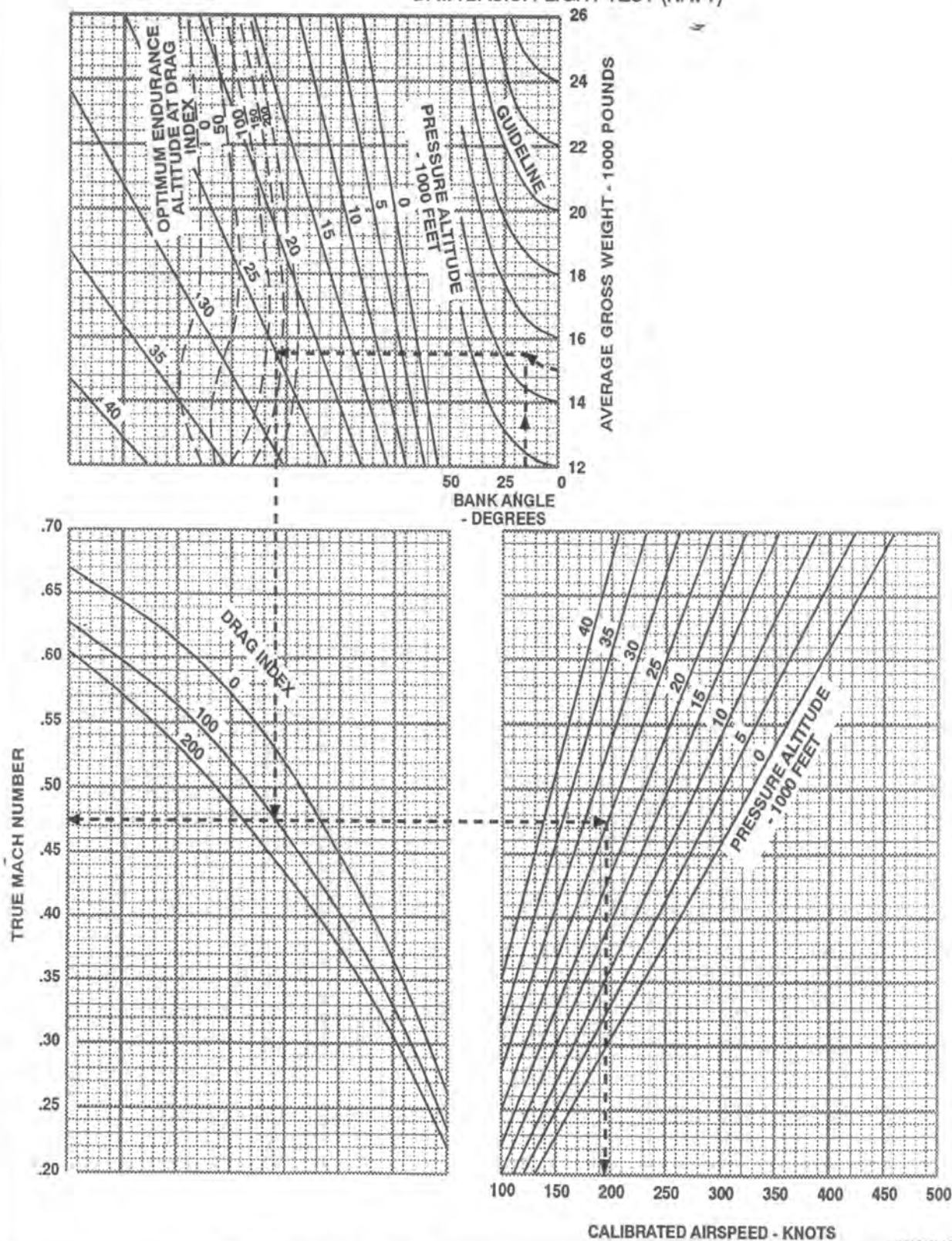
Figure 9-66 Maximum Endurance Fuel A-4

AL 7(0)

MAXIMUM ENDURANCE SPEED

MODEL: TA-4F
ENGINE: J52-P-8B/C

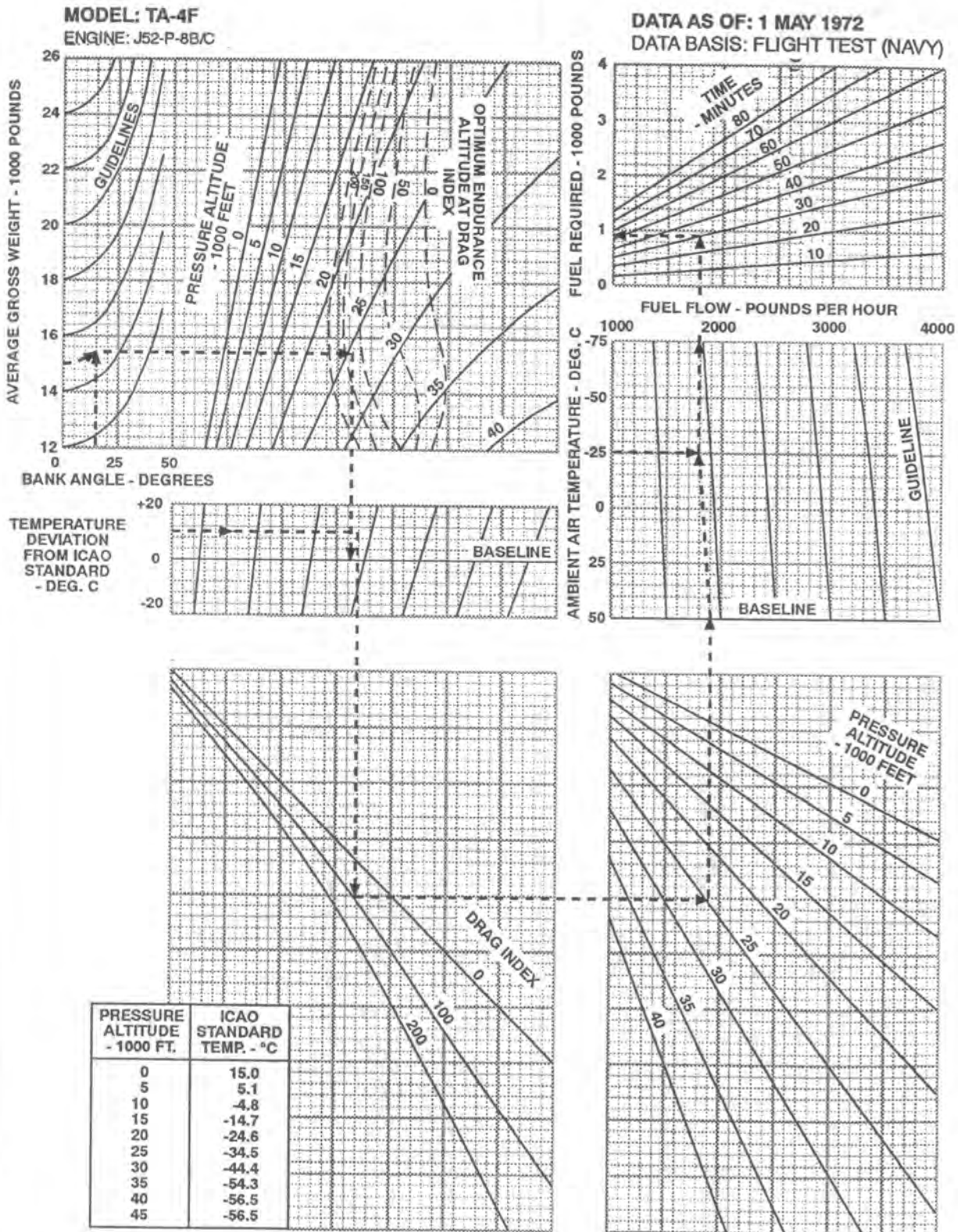
DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1745

Figure 9-67 Maximum Endurance Speed TA-4

MAXIMUM ENDURANCE FUEL



WN1746

Figure 9-68 Maximum Endurance Fuel TA-4

AIR REFUELLING

AIR REFUELLING CHARTS

9.50 The air refuelling charts present the performance of a tanker configured with an air-refuelling buddy store on the centreline pylon, four wing pylons, two 300-gallon external fuel tanks, and two 20mm guns. All performance data shown are based on an ICAO standard atmosphere.

TANKER SPEED ENVELOPE

9.51 The operating speed envelope of the tanker aircraft is shown in Figure 9-73. Data are presented for both drogue extended and drogue retracted configurations as a function of gross weight..

SAMPLE PROBLEM

Tanker Speed Envelope

(For Figure 9-73)

- (A) Pressure altitude 20,000 ft
- (B) Gross weight hose and drogue extended 24,000 lb
- (C) Minimum refuelling Mach number 0.506
- (D) Maximum refuelling calibrated airspeed 300 Kts
- (E) Maximum refuelling Mach number 0.65
- (F) Gross weight hose and drogue retracted 24,000 lb
- (G) Maximum Mach number 0.83

TANKER FUEL AVAILABLE FOR TRANSFER

9.52 The tanker fuel available for transfer is shown as a function of radius in Figure 9-74 and Figure 9-75 for

operation with JP-4 or JP-5 fuel. These data are presented, assuming standard buddy-tanker reserves consisting of fuel for 20 minutes of maximum endurance at sea level plus 5 percent of all fuel not transferred. In addition, a fuel allowance for rendezvous and hook-up has been added. This allowance consists of fuel for 5 minutes at speed for maximum endurance, with hose and drogue extended, at 30,000 feet pressure altitude.

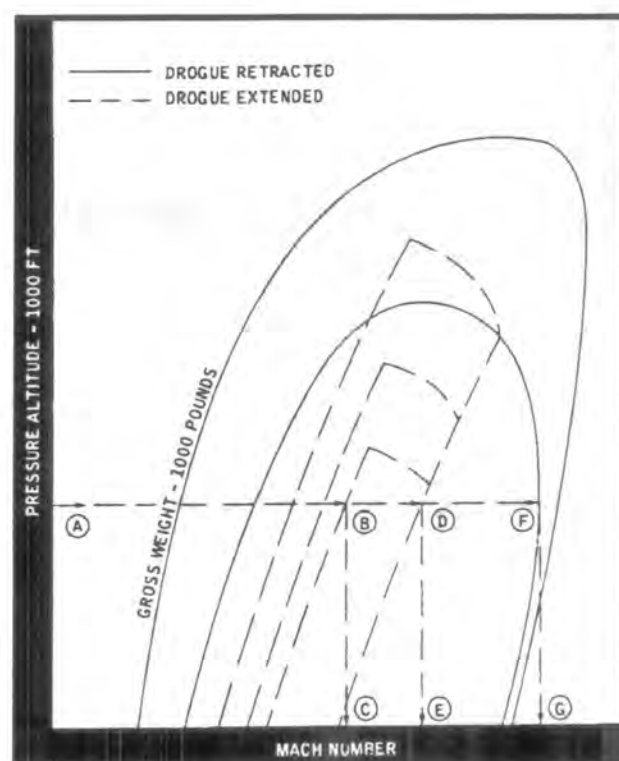


Figure 9-69 Sample Tanker Speed Envelope

9.53 As shown in Figure 9-74, refuelling radii of less than 275 nautical miles with JP-5 fuel and less than 250 nautical miles with JP-4 fuel, the tanker is unable to consume all of the 320 gallons of nontransferable fuel. Therefore, if refuelling is accomplished at radii less than those noted and all the available fuel is transferred, the tanker will return to base with an excess of reserve fuel.

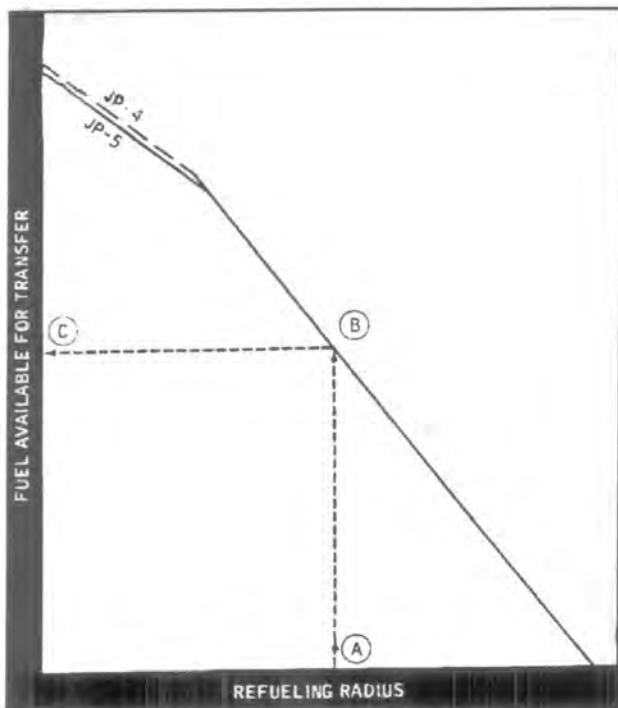


Figure 9-70 Sample Tanker Fuel Available For Transfer

SAMPLE PROBLEM

Tanker Fuel Available for Transfer

(For Figure 9-74)

- (A) Refuelling radius 400 NMI
- (B) JP-5 fuel line
- (C) Fuel available for transfer 4880 lb

TANKER FUEL TRANSFER TIME

9.54 The relationship of fuel transferred to receiver versus elapsed time is presented in Figure 9-76 and Figure 9-77. The flow rate to the receiver aircraft is 180 gallons per minute. After 2.85 minutes, refuelling is temporarily discontinued to allow the refuelling store to fill from the external fuel tanks. The maximum amount of fuel that can be transferred to the receiver during a continuous refuelling operation is limited to 513 gallons.

9.55 The limiting factor is the external transfer rate of tanker fuel from the external fuel tanks and wing tanks to

the refuelling store. If more than 513 gallons is to be transferred to the receiver, refuelling must be discontinued to allow the refuelling store to be replenished from the tanker internal fuel. The time delay is dependent upon the amount of additional fuel to be transferred.

SAMPLE PROBLEM

Tanker Fuel Transfer Time

(For Figure 9-76)

- (A) Fuel transferred to receiver (JP-5) 4600 lb
- (B) JP-5 fuel flow line
- (C) Elapsed time 4.87 min
- (D) Point where refuelling is resumed 4.04 min
- (E) Point where refuelling is temporarily discontinued 2.85 min

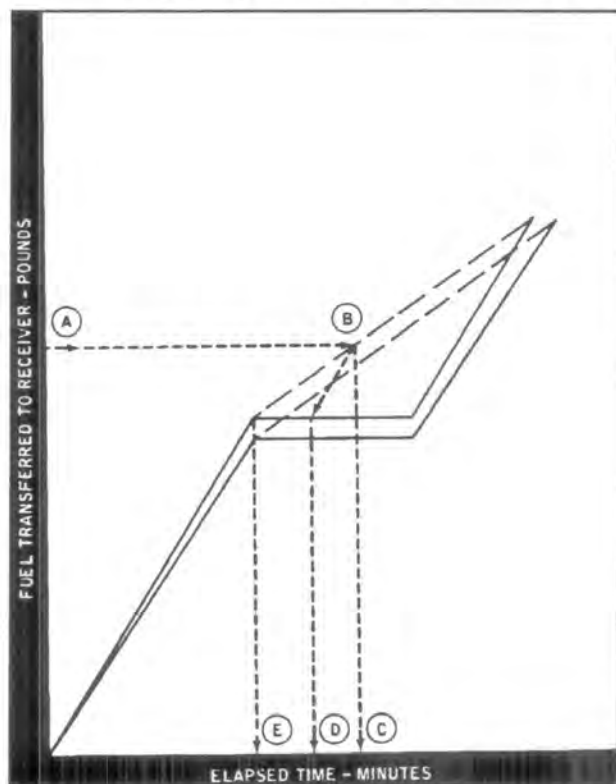


Figure 9-71 Sample Tanker Fuel Transfer Time

FUEL CONSUMPTION OF TANKER DURING AIR REFUELLING

9.56 The tanker fuel consumption with the hose and drogue extended is presented in Figure 9-78 and Figure 9-79 for two pressure altitudes for speeds throughout the flight envelope.

SAMPLE PROBLEM

Fuel Consumption of Tanker During Air Refuelling

(For Figure 9-78)

- (A) Refuelling speed 250 KCAS
- (B) Gross weight 20,000 lb
- (C) Fuel flow 20,000 ft 2690 lb/hr
- (D) Fuel flow 30,000 ft 3090 lb/hr

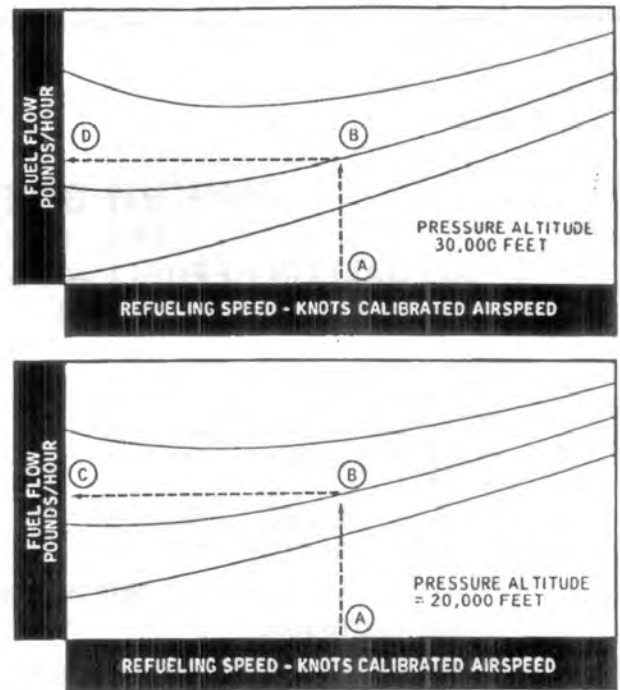


Figure 9-72 Sample Tanker Fuel Consumption During Air Refuelling

TANKER SPEED ENVELOPE

TANKER CONFIGURATION

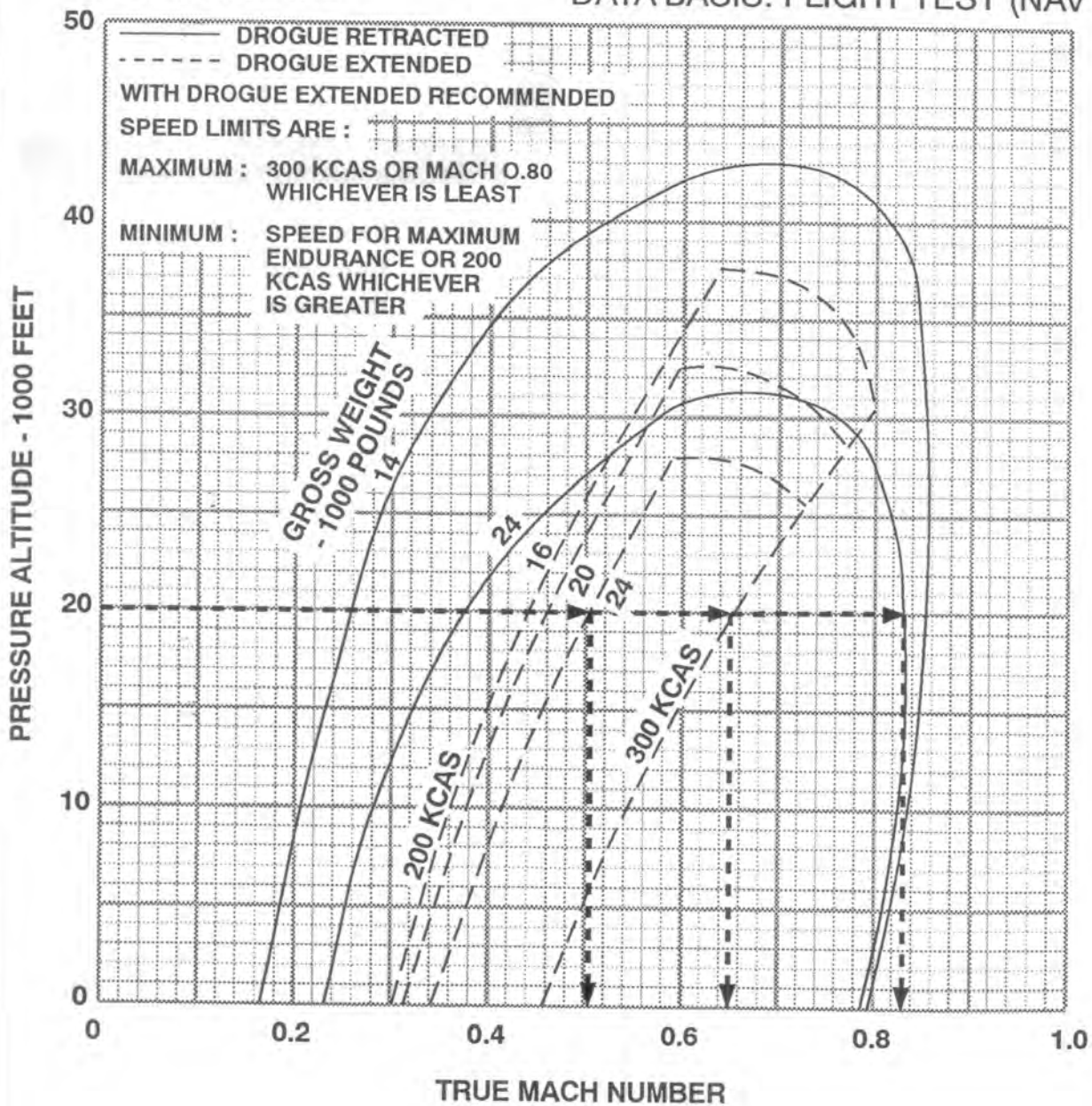
1 - 300 GALLON REFUELLING STORE PLUS 2 - 300 GALLON TANKS
5 - PYLONS AND GUNS

MODEL: A - 4F/ TA - 4F

ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972

DATA BASIS: FLIGHT TEST (NAVY)



WN1747

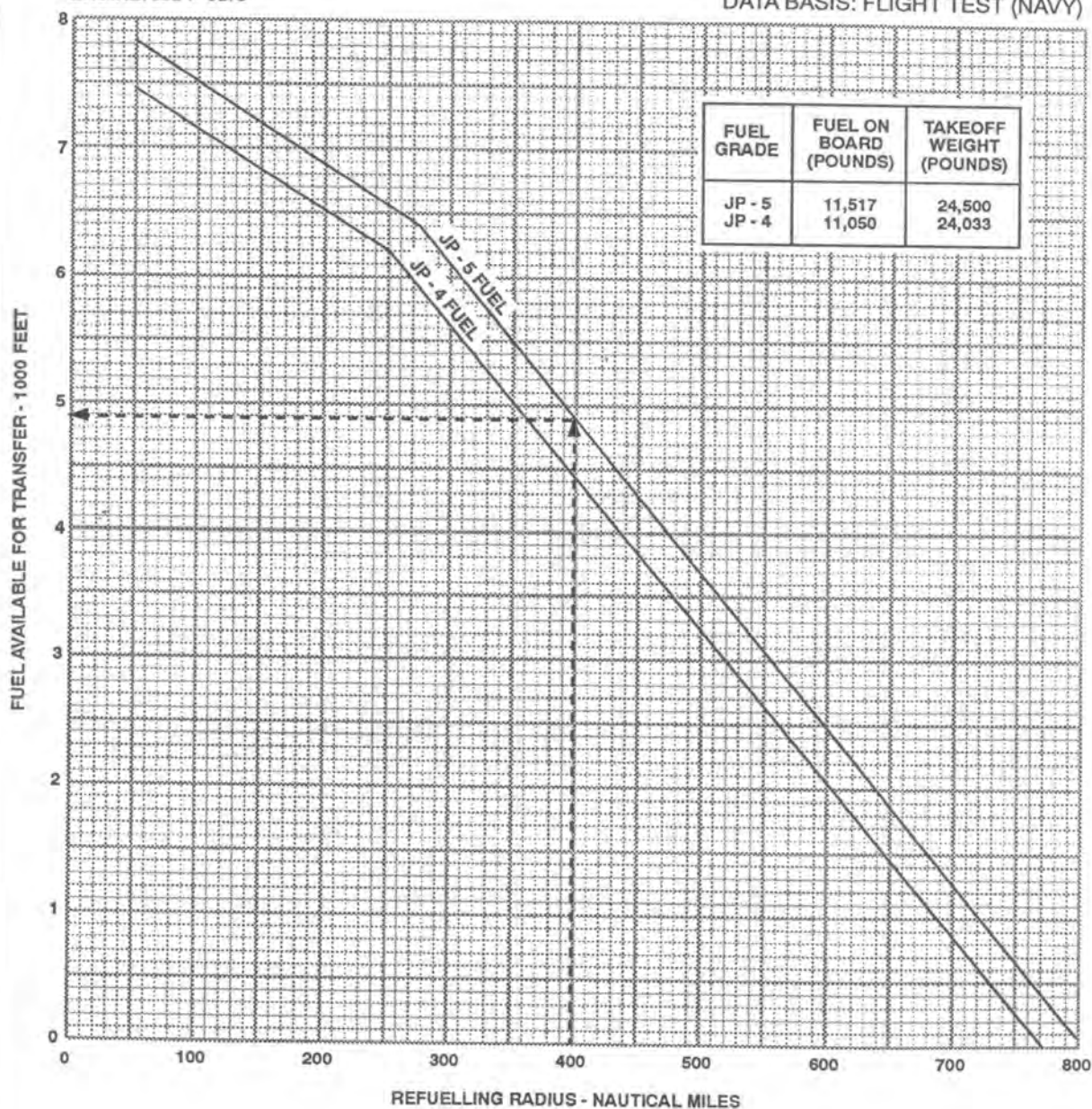
Figure 9-73 Tanker Speed Envelope

AL 7(0)

TANKER FUEL AVAILABLE FOR TRANSFER 1 - 300 GALLON REFUELLING STORE PLUS 2 - 300 GALLON TANKS 5 - PYLONS, GUNS AND AMMO

MODEL: A-4F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)



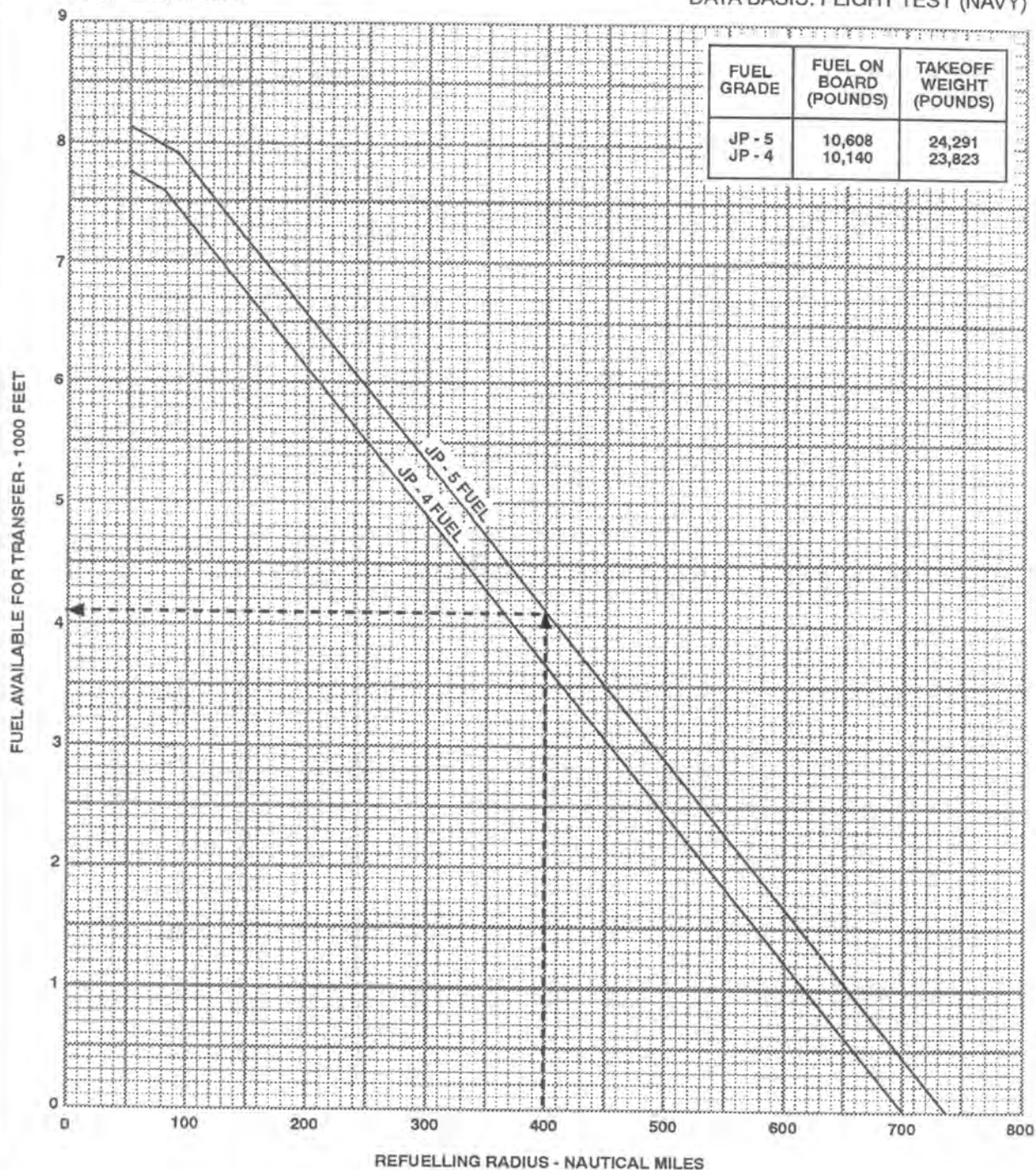
WN1748

Figure 9-74 Tanker Fuel Available For Transfer A-4

TANKER FUEL AVAILABLE FOR TRANSFER 1 - 300 GALLON REFUELLING STORE PLUS 2 - 300 GALLON TANKS 5 - PYLONS, GUNS AND AMMO

MODEL: TA-4F
 ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
 DATA BASIS: FLIGHT TEST (NAVY)



WN1750

Figure 9-75 Tanker Fuel Available For Transfer TA-4

AL 7(0)

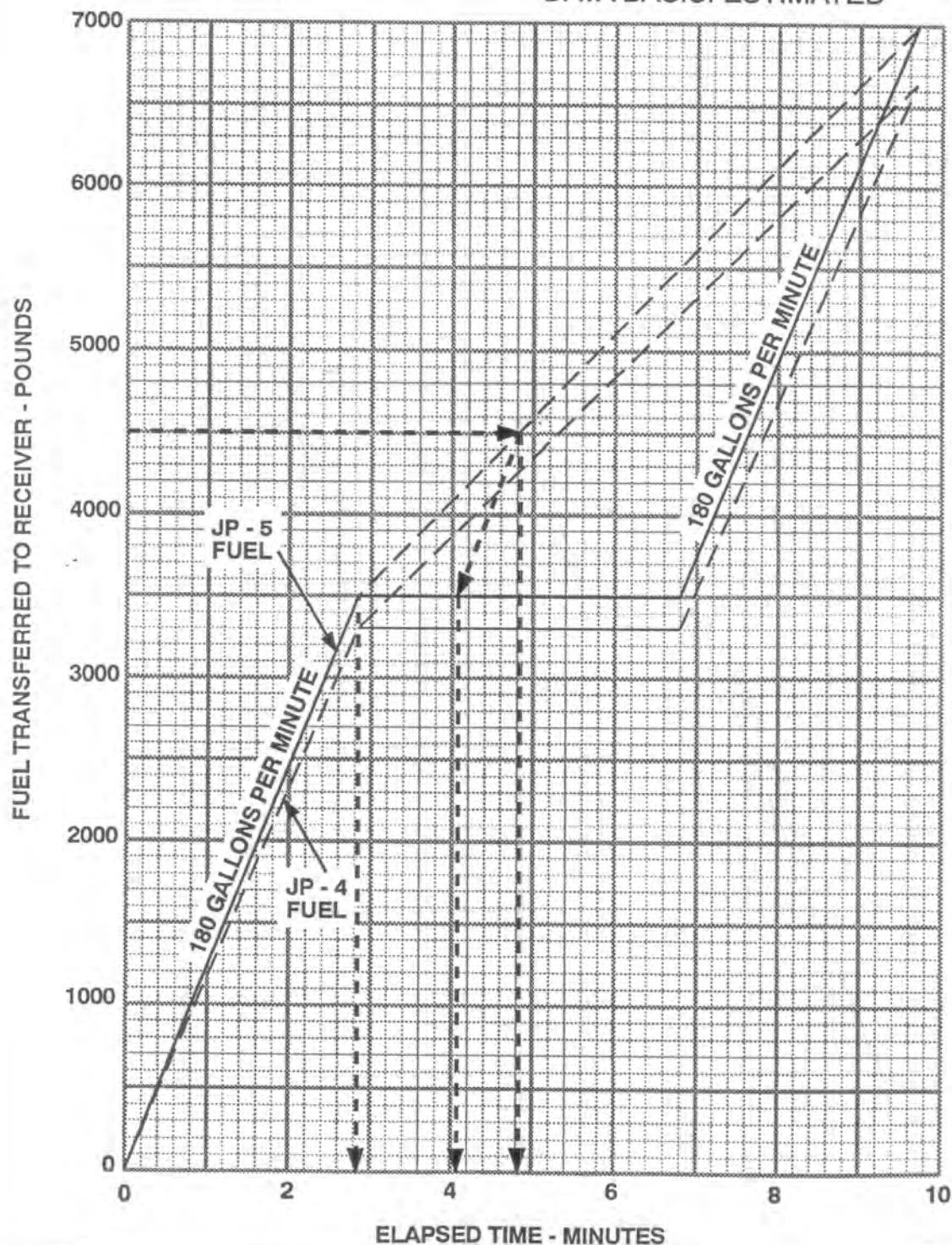
TANKER FUEL TRANSFER TIME TANKER CONFIGURATION

MODEL: A-4E/F

ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972

DATA BASIS: ESTIMATED



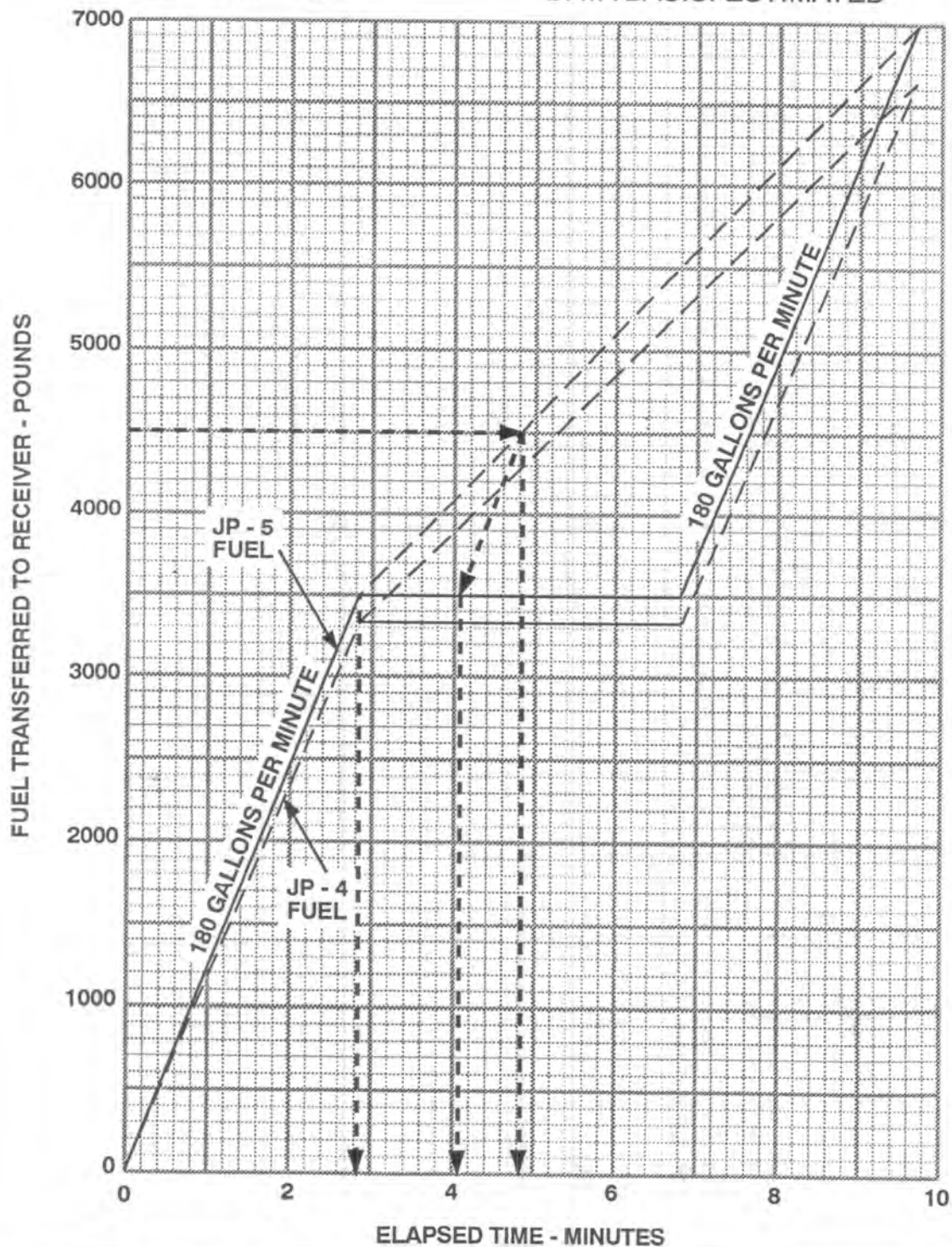
WN1749

Figure 9-76 Tanker Fuel Transfer Time A-4

TANKER FUEL TRANSFER TIME **TANKER CONFIGURATION**

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: ESTIMATED



WN1751

Figure 9-77 Tanker Fuel Transfer Time TA-4

AL 7(0)

FUEL CONSUMPTION OF TANKER DURING AIR REFUELLING

1 - 300 GALLON REFUELLING STORE PLUS 2 - 300 GALLON TANKS

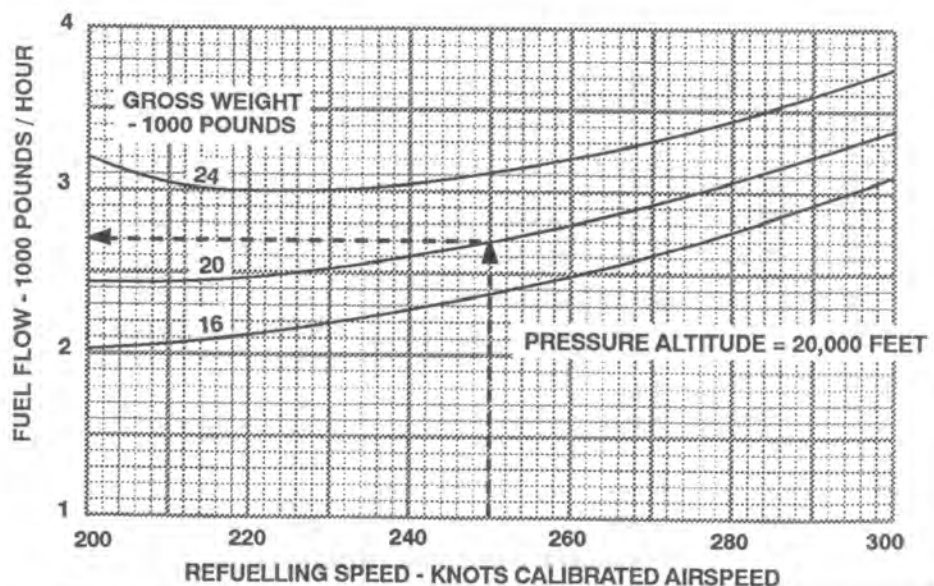
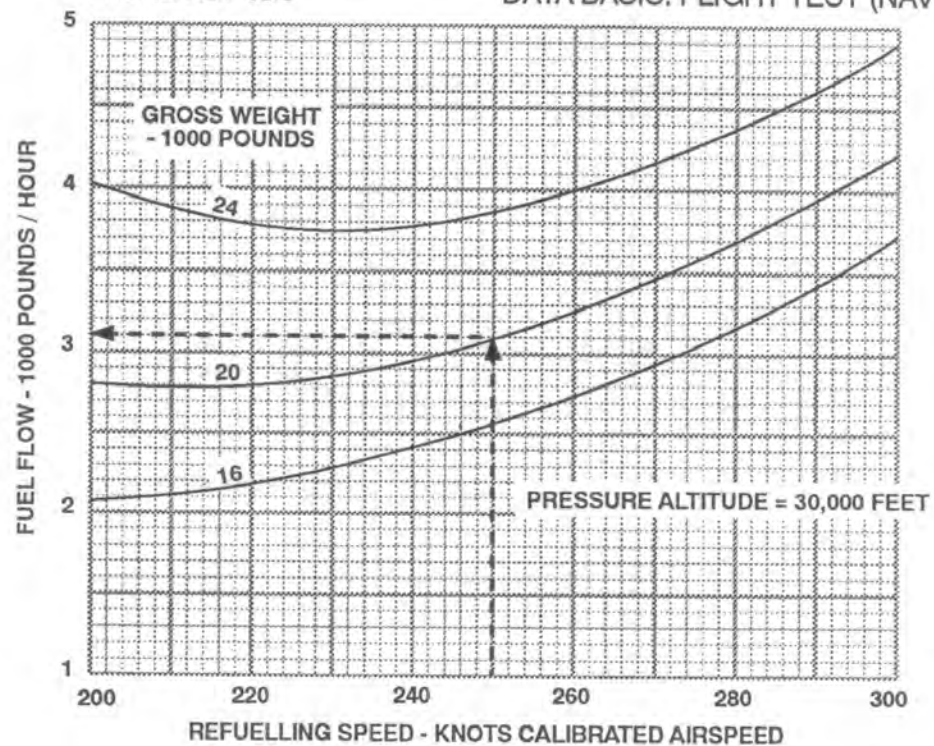
5 - PYLONS, GUNS AND AMMO

MODEL: A-4F

ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972

DATA BASIS: FLIGHT TEST (NAVY)



WN1752

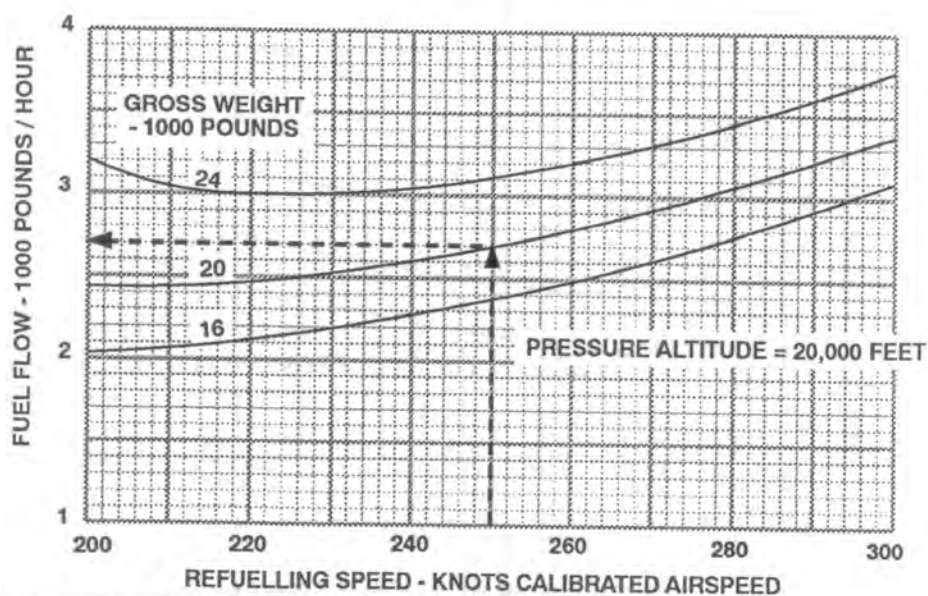
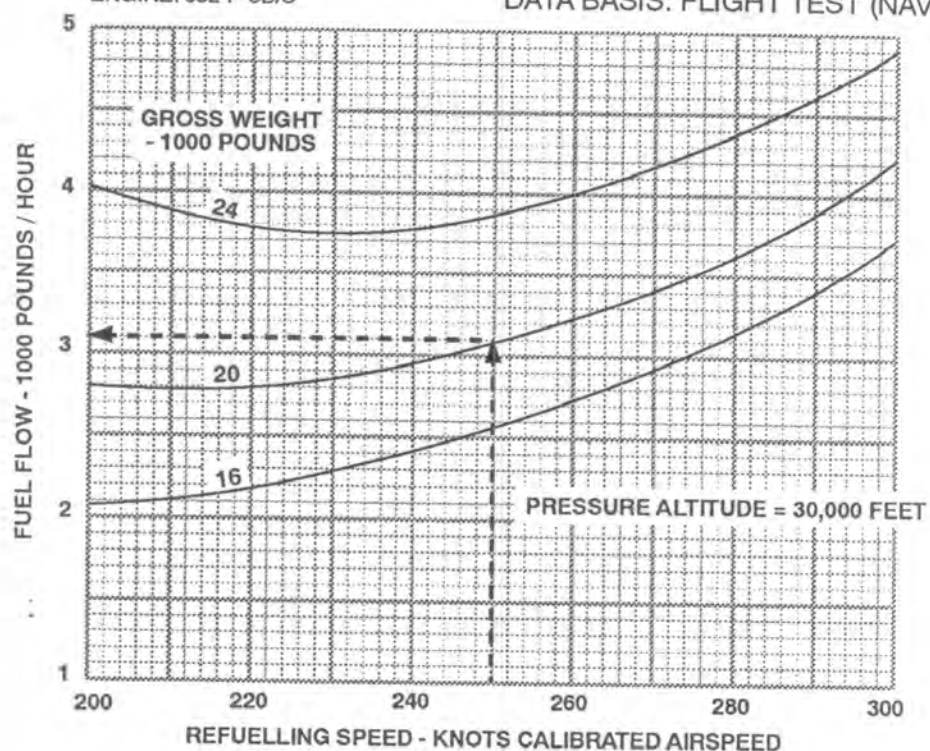
Figure 9-78 Fuel Consumption Of Tanker During Air Refuelling A-4

FUEL CONSUMPTION OF TANKER DURING AIR REFUELLING

1 - 300 GALLON REFUELLING STORE PLUS 2 - 300 GALLON TANKS
5 - PYLONS, GUNS AND AMMO

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1753

Figure 9-79 Fuel Consumption Of Tanker During Air Refuelling TA-4

DESCENT

MAXIMUM RANGE DESCENT

9.57 Graphical data are presented in Figure 9-81 through Figure 9-86 for maximum range descent using idle thrust and with speedbrakes closed. Recommended maximum range descent speed, fuel consumed, distance covered, and elapsed time from any desired altitude to sea level are presented as a function of gross weight and drag index. All data is based on an ICAO standard atmosphere. The method of presenting data for fuel, distance, and time is identical. Therefore, only one sample problem is shown.

SAMPLE PROBLEM

Descent Fuel

(For Figure 9-81)

- (A) Initial gross weight 14,000 lb
- (B) Cruise altitude 35,000 ft
- (C) Drag index 100
- (D) Fuel required from cruise
altitude to sea level 100 lb

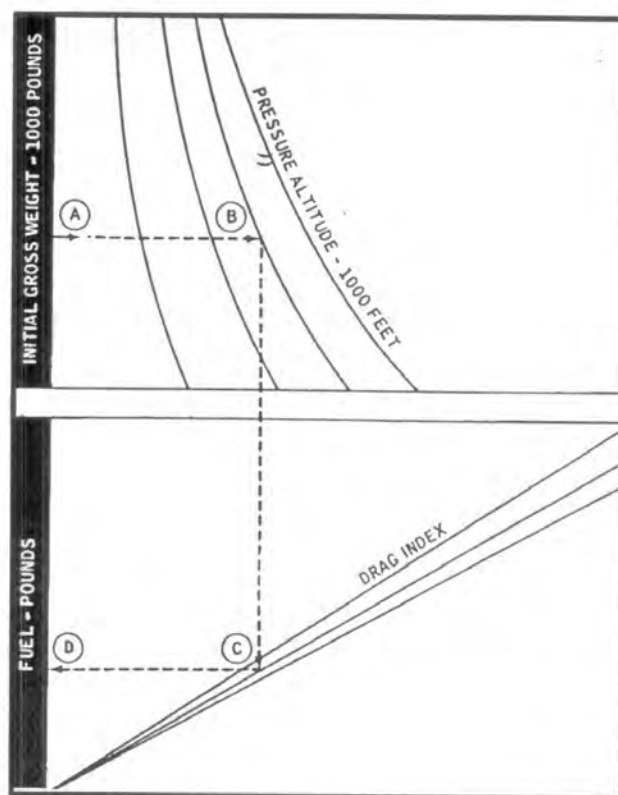


Figure 9-80 Sample Descent Fuel

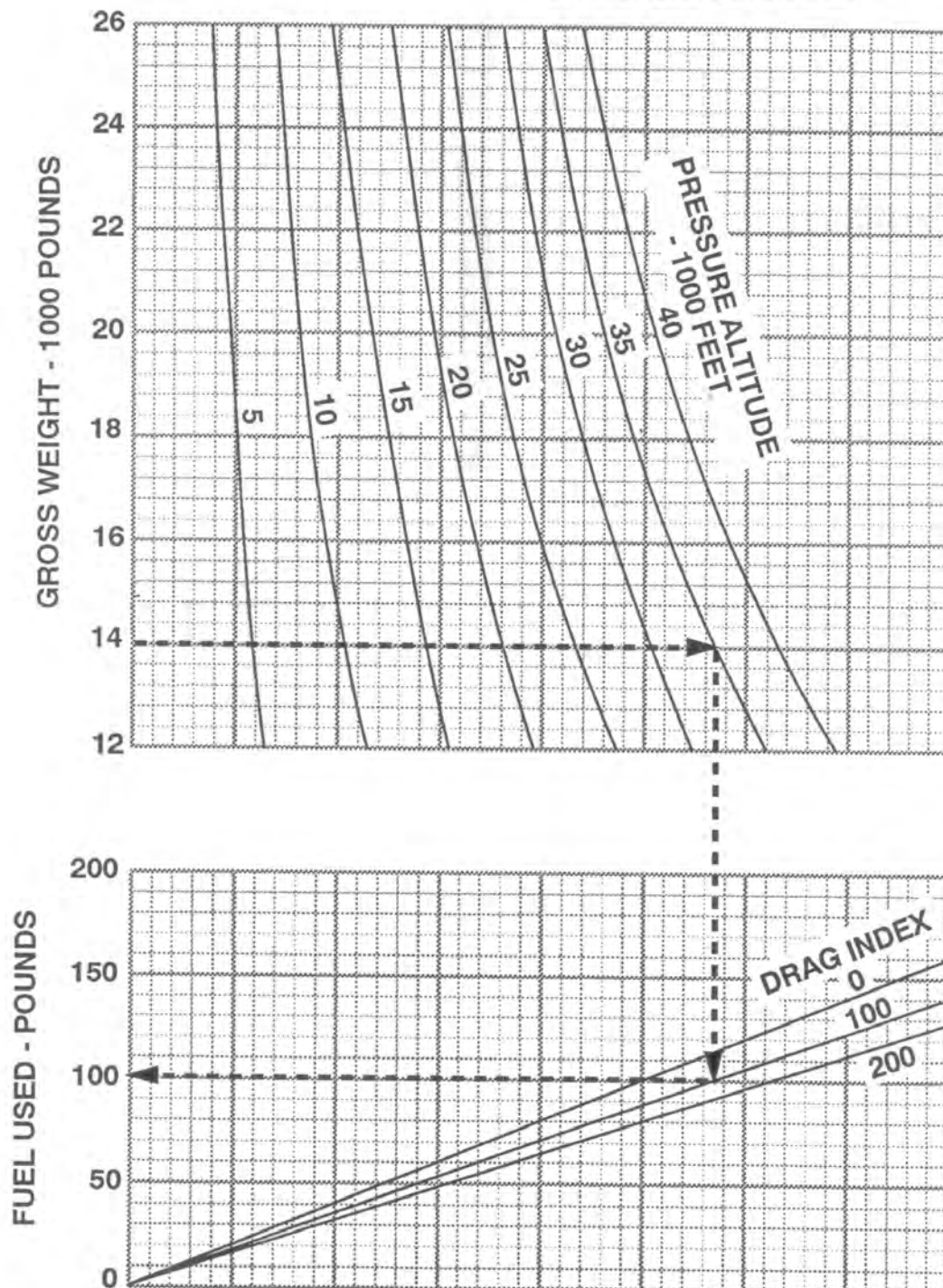
NOTE

From Figure 9-83, descent speed is 190 KCAS.

DESCENT FUEL IDLE THRUST GEAR UP - FLAPS UP SPEEDBRAKES RETRACTED

MODEL: A-4E/F
 ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
 DATA BASIS: ESTIMATED



WN1754

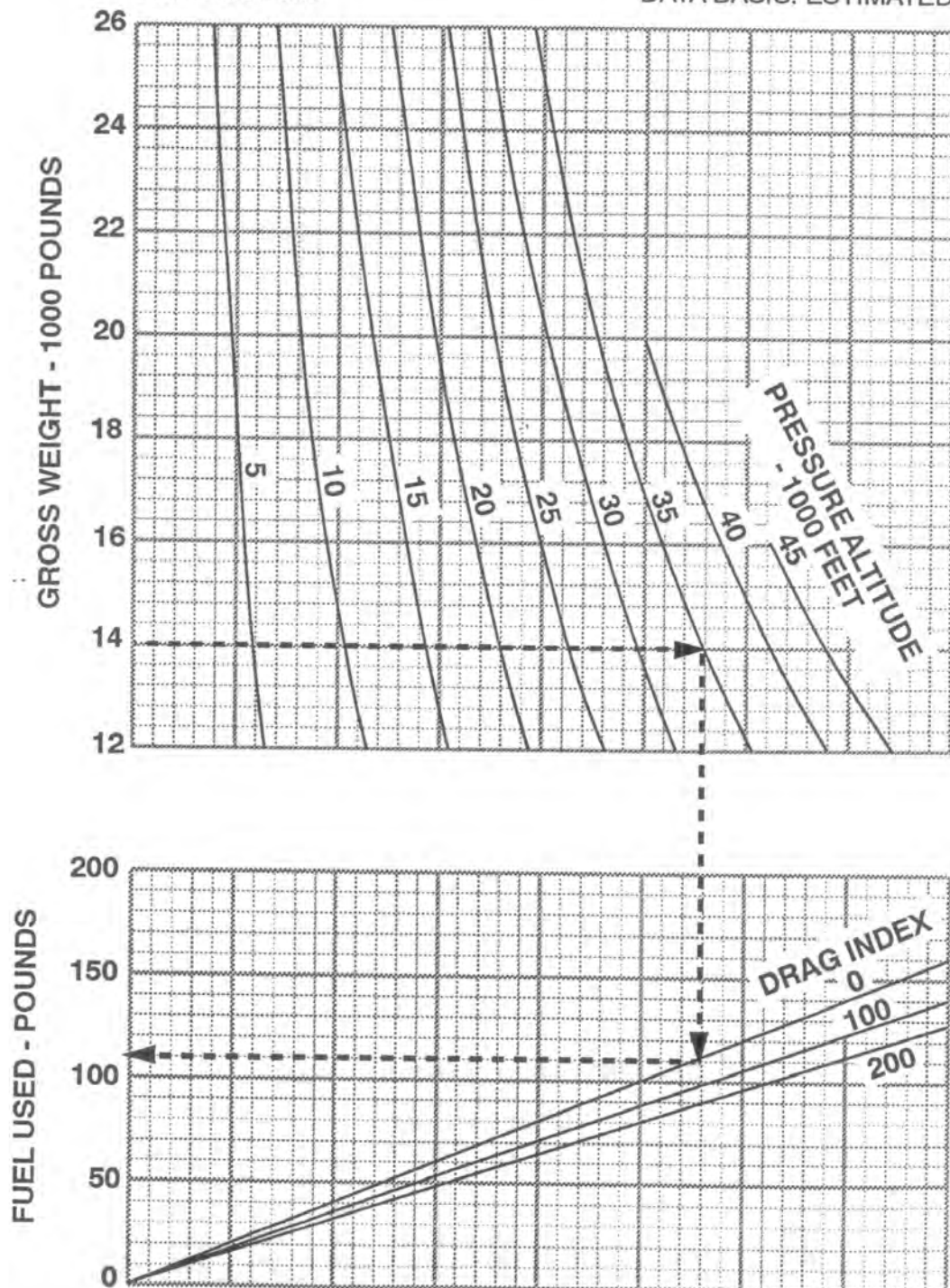
Figure 9-81 Descent Fuel A-4

AL 7(0)

DESCENT FUEL **IDLE THRUST** **GEAR UP - FLAPS UP** **SPEEDBRAKES RETRACTED**

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: ESTIMATED



WN1755

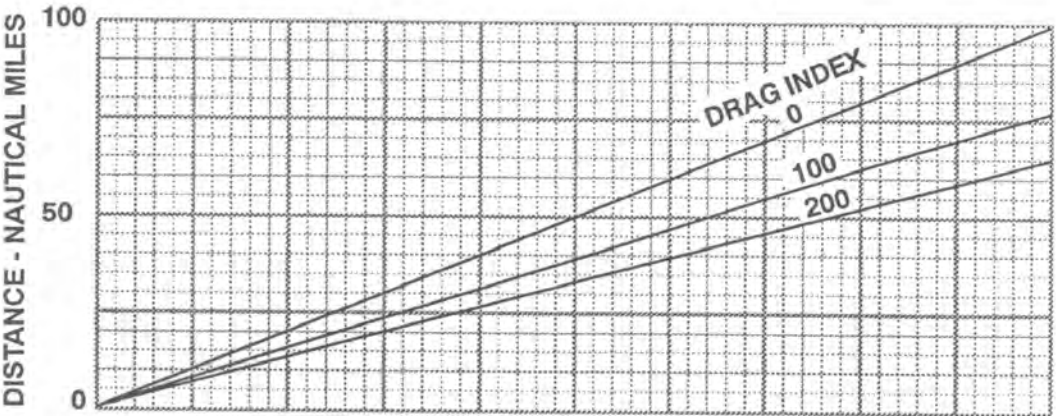
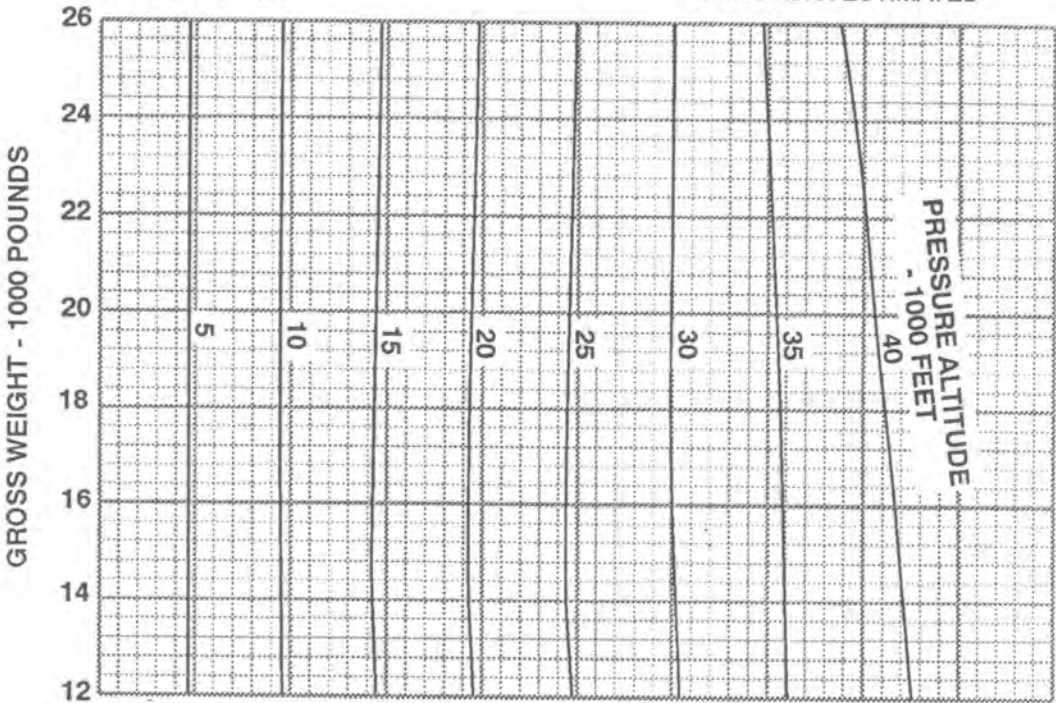
Figure 9-82 Descent Fuel TA-4

DESCENT DISTANCE

**IDLE THRUST
GEAR UP - FLAPS UP
SPEEDBRAKES RETRACTED**

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: ESTIMATED



DESCENT SPEED SCHEDULE - KCAS

DRAG INDEX	GROSS WEIGHT - 1000 POUNDS							
	12	14	16	18	20	22	24	26
0	195	210	225	235	250	260	275	280
100	175	190	200	210	225	235	245	255
200	160	175	185	195	210	220	230	235

WN1756

Figure 9-83 Descent Distance A-4

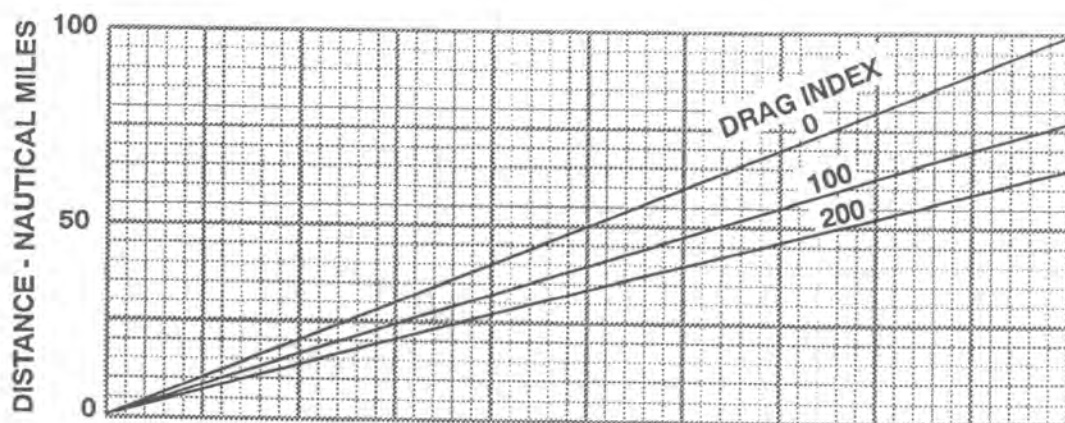
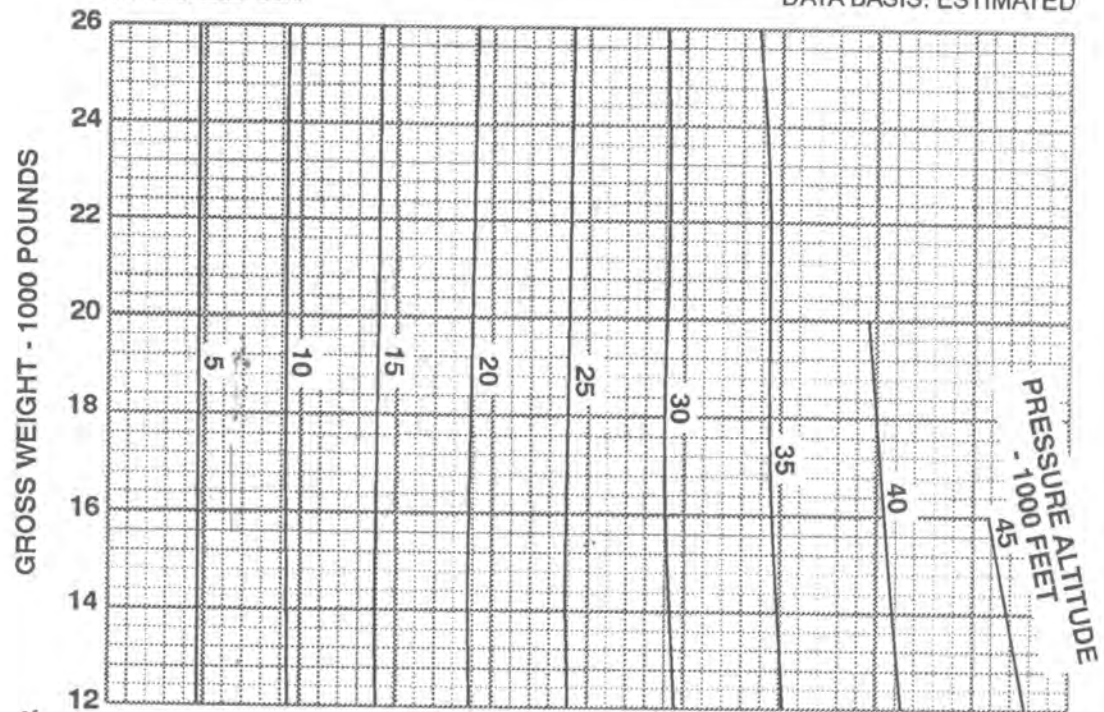
AL 7(0)

DESCENT DISTANCE

IDLE THRUST
GEAR UP - FLAPS UP
SPEEDBRAKES RETRACTED

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: ESTIMATED



DESCENT SPEED SCHEDULE - KCAS

DRAG INDEX	GROSS WEIGHT - 1000 POUNDS							
	12	14	16	18	20	22	24	26
0	190	205	220	235	245	260	270	280
100	175	185	200	210	220	230	240	250
200	160	175	185	195	205	215	225	235

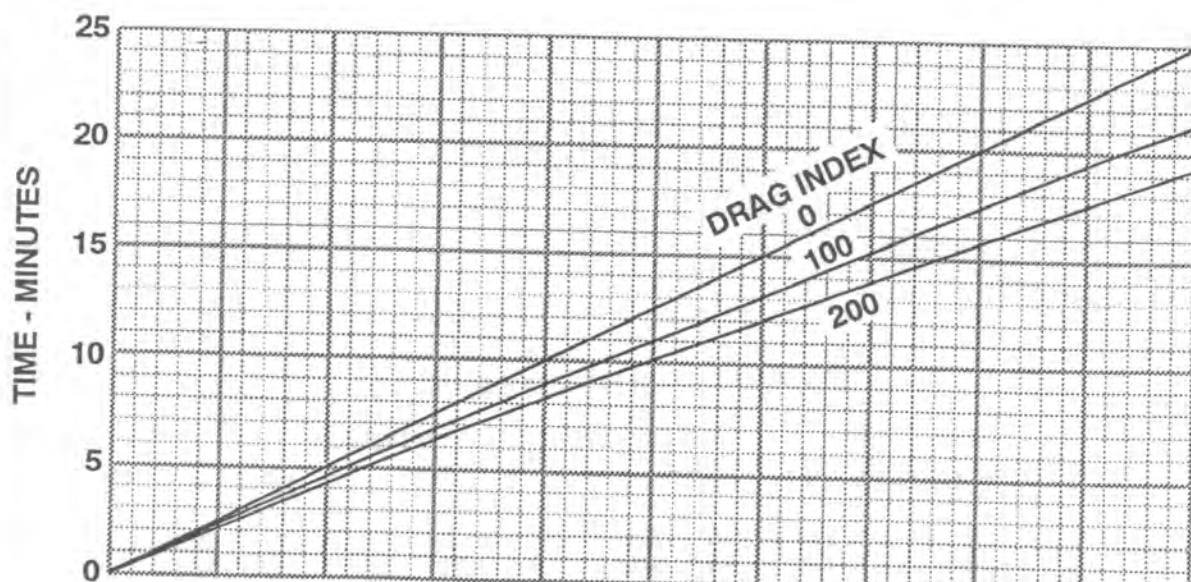
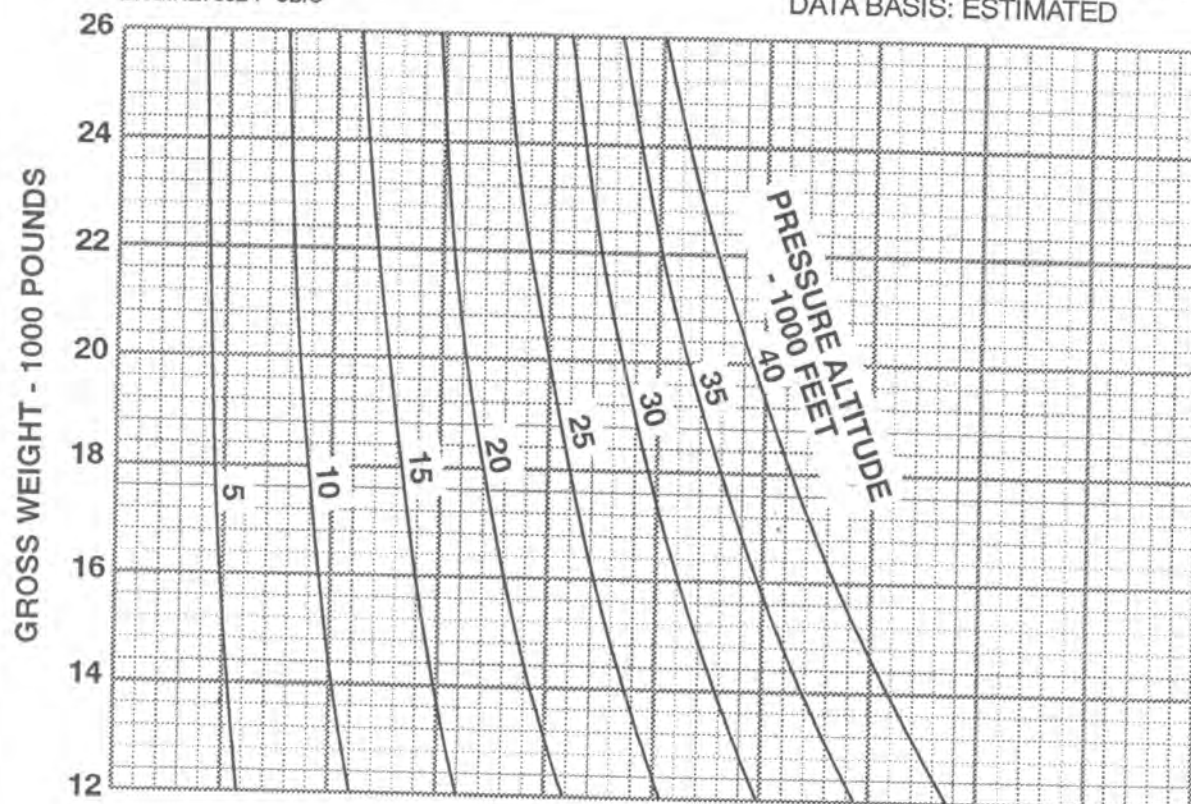
WN1758

Figure 9-84 Descent Distance TA-4

DESCENT TIME IDLE THRUST GEAR UP - FLAPS UP SPEEDBRAKES RETRACTED

MODEL: A-4E/F
 ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
 DATA BASIS: ESTIMATED



WN1757

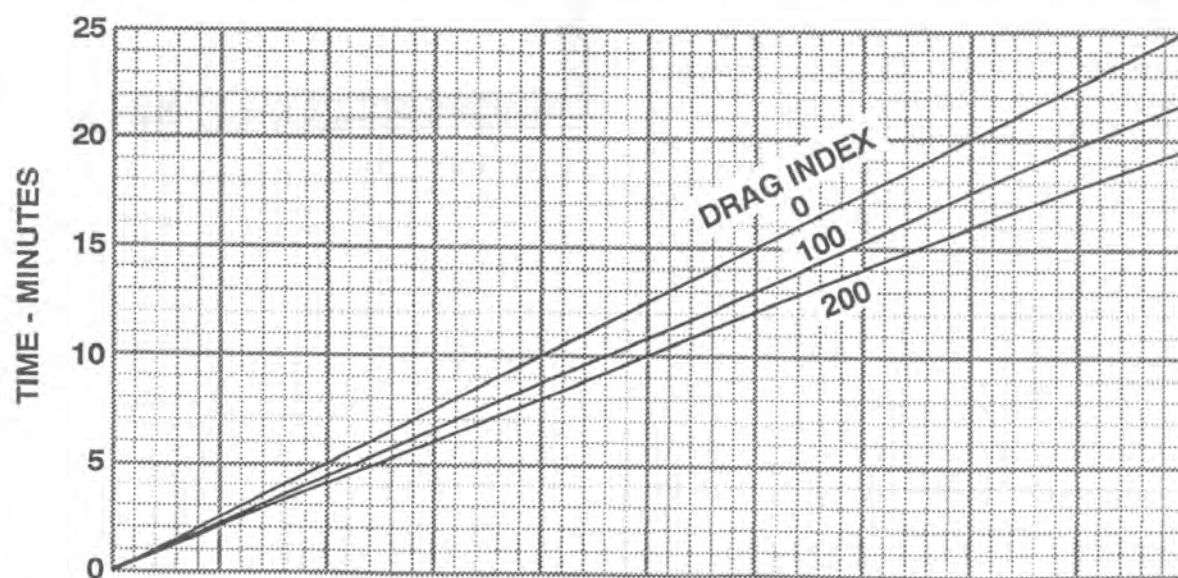
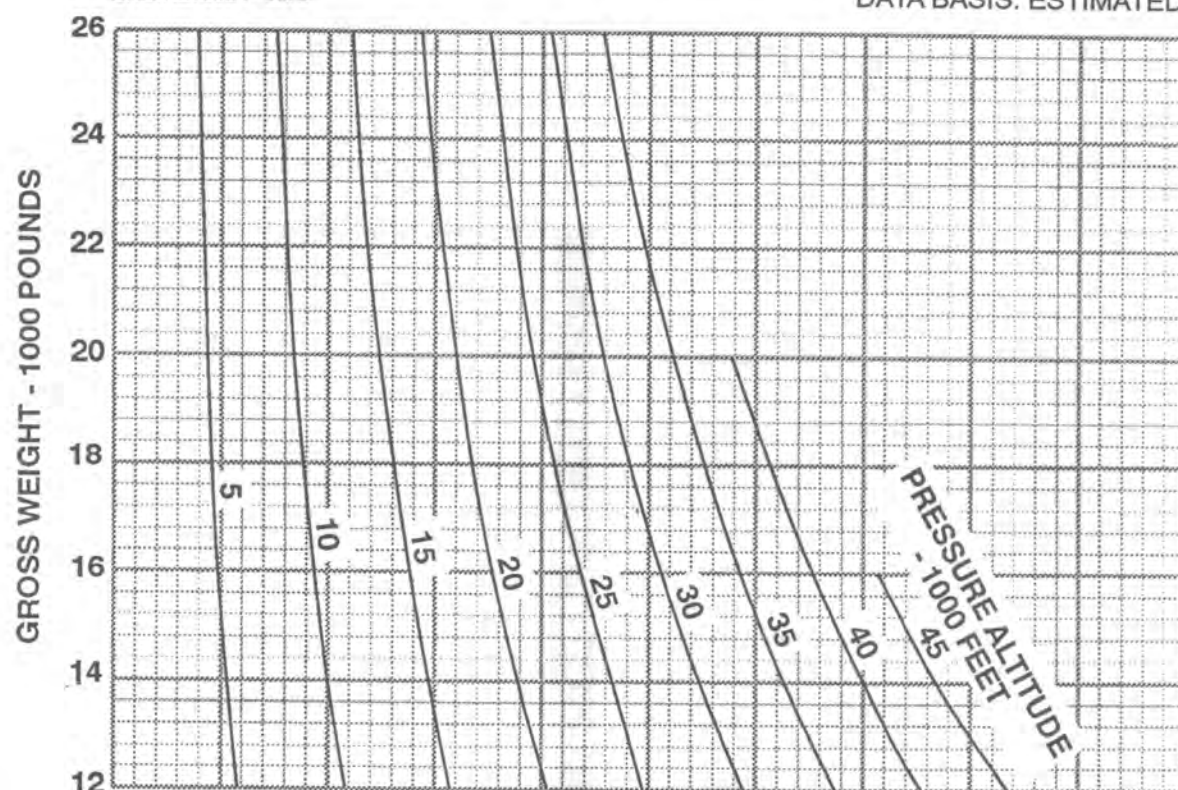
Figure 9-85 Descent Time A-4

AL 7(0)

DESCENT TIME **IDLE THRUST** **GEAR UP - FLAPS UP** **SPEEDBRAKES RETRACTED**

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: ESTIMATED



WN1759

Figure 9-86 Descent Time TA-4

LANDING

LANDING

9.58 Approach speeds, stall speeds for landing configurations, and corresponding angle-of-attack units are presented in Figure 9-89 and Figure 9-90. The speeds are shown as indicated airspeeds. If an angle-of-attack indication of 17.5 units with flaps fully extended does not produce the indicated airspeed for the configuration computed from Figure 9-89 and Figure 9-90, check the aircraft configuration. If the appropriate configuration is established, disregard the angle-of-attack indicator and make the approach at the indicated airspeed from Figure 9-89 and Figure 9-90.

9.59 The landing ground roll of the aircraft is dependent upon runway pressure altitude, outside air temperature, the force of the head-wind, flap deflection, run-way gradient, and braking action. The ground roll distance, as given in Figure 9-91, is calculated assuming maximum braking action without skidding the tires, and aerodynamic braking produced with the speedbrakes and spoilers extended, and the wing flaps at any setting. A graph is provided for determining landing distance for various runway conditions including hard dry, wet, snow-covered, and icy runways, both with spoilers open and without spoilers. The distance to clear a 50-foot obstacle is measured horizontally from the 50-foot obstacle to the end of roll out and is obtained by adding 715 feet to the ground roll distance, assuming a standard 4-degree glide slope. Obviously, if the obstacle is situated at a distance from the runway which is greater than the ground distance required (715 feet) to descend from 50 feet, it will have no effect on the usable runway length. If the obstacle is very near the runway, that portion of runway length consumed in the descent from 50 feet may not leave enough distance to brake to a stop.

SAMPLE PROBLEM

Approach Speed

(For Figure 9-89 and Figure 9-90)

- (A) Gross weight 12,000 lb
- (B) Stall speed (Full flaps) 99.7 KIAS
Angle-of-attack 25.4 units A-4
22.3 units TA-4
- (C) Approach speed (Full flaps) 116.3 KIAS
Angle-of-attack 17.5 units A-4
16.5 units TA-4

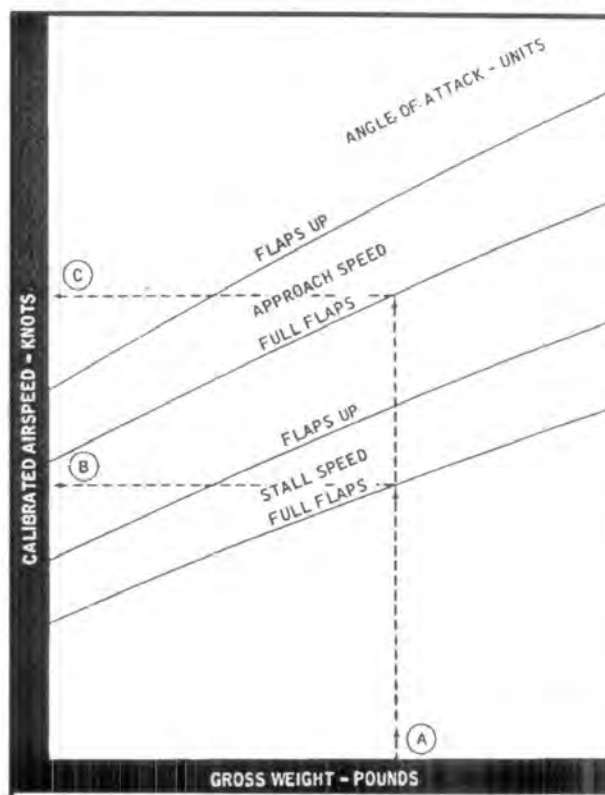


Figure 9-87 Sample Approach Speed

SAMPLE PROBLEM

Landing Distance

(For Figure 9-91, sheet 2)

9.60 Runway Condition: Wet RCR 15

- (A) Outside air temperature 20°C
 (B) Runway pressure altitude 2000 ft
 (C) Aircraft landing weight 12 000 lb
 (D) Flap deflection half
 (E) Headwind 15 Kts
 (F) Runway gradient -1 percent
 (G) Ground roll distance 4100 ft
 Total distance to clear a
 50-foot obstacle with
 4-degree glide slope 4815 ft

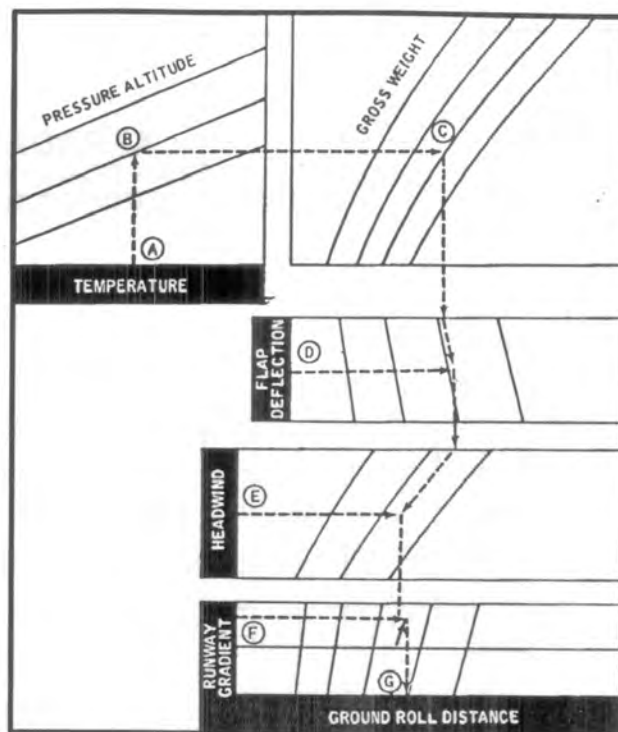
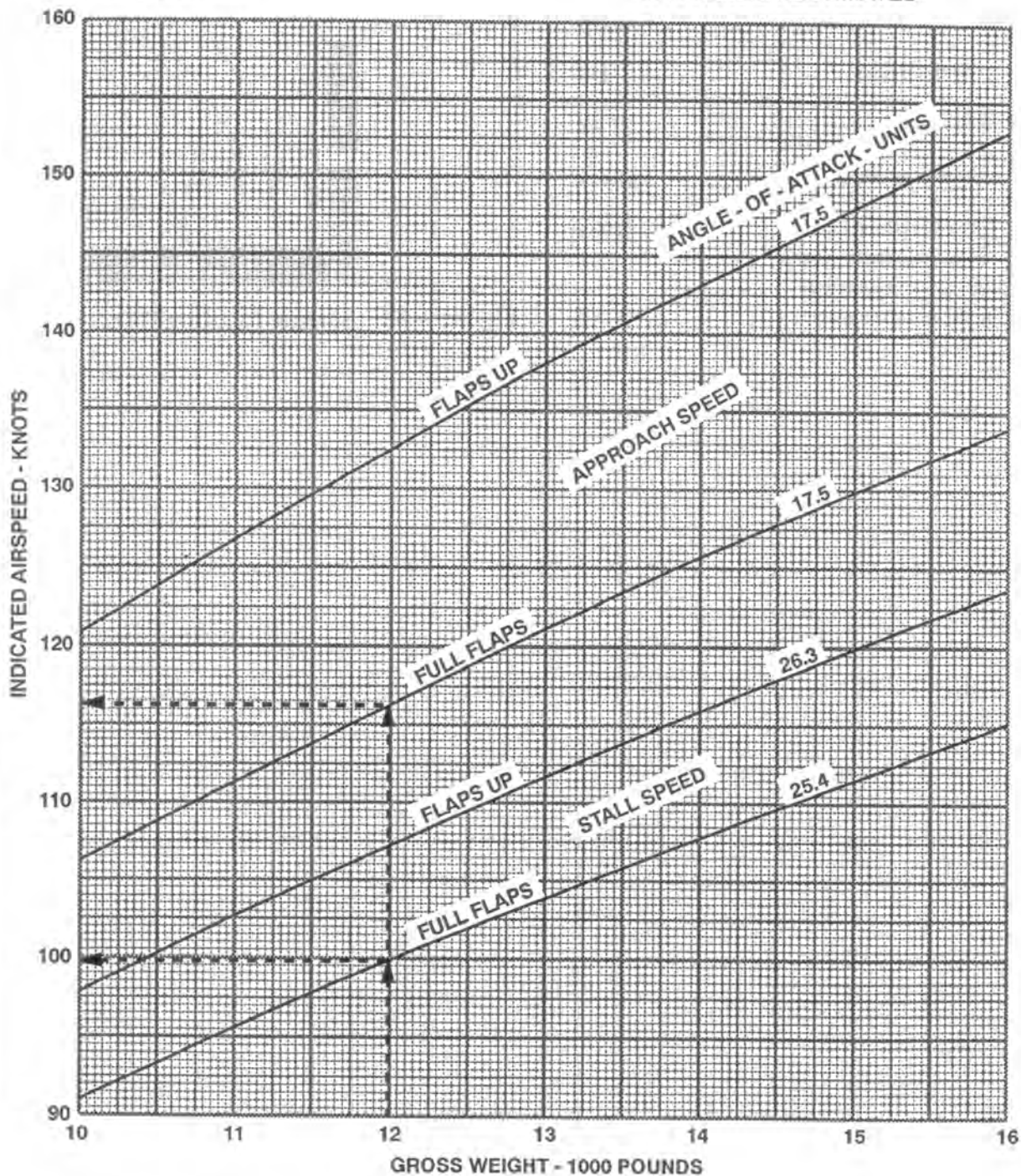


Figure 9-88 Sample Landing Distance

APPROACH SPEED GEAR DOWN - SPEEDBRAKES OPEN THRUST REQUIRED TO MAINTAIN 4° GLIDE SLOPE

MODEL : A-4F
ENGINE : J52-P-8B/C

DATA AS OF : 1 SEPTEMBER 1968
DATA BASIS : ESTIMATED



WN1760

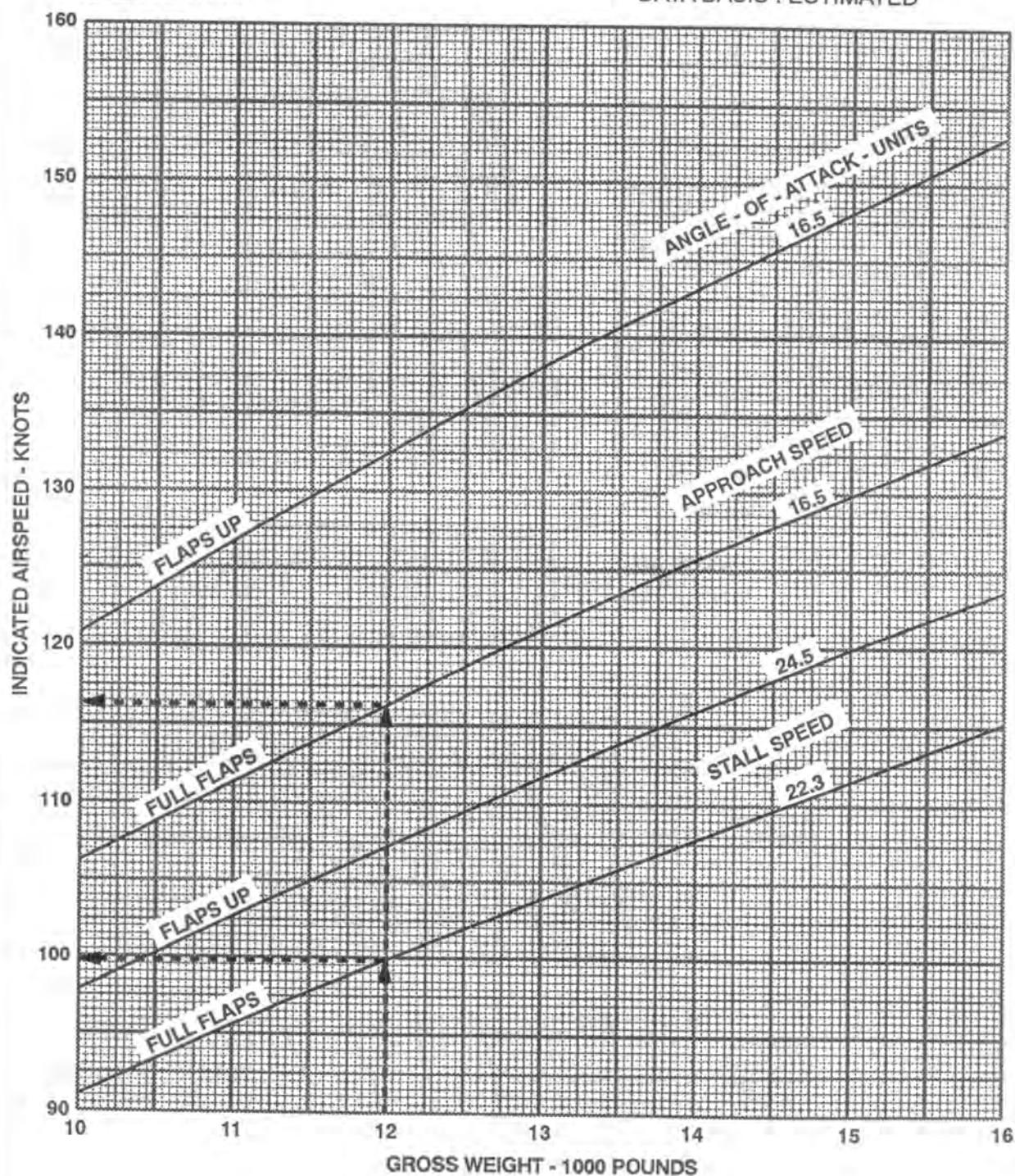
Figure 9-89 Approach Speed A-4

AL 7(0)

APPROACH SPEED **GEAR DOWN - SPEEDBRAKES OPEN** **THRUST REQUIRED TO MAINTAIN 4° GLIDE SLOPE**

MODEL : TA-4F
 ENGINE : J52-P-8B/C

DATA AS OF : 20 AUGUST 1968
 DATA BASIS : ESTIMATED



WN1762

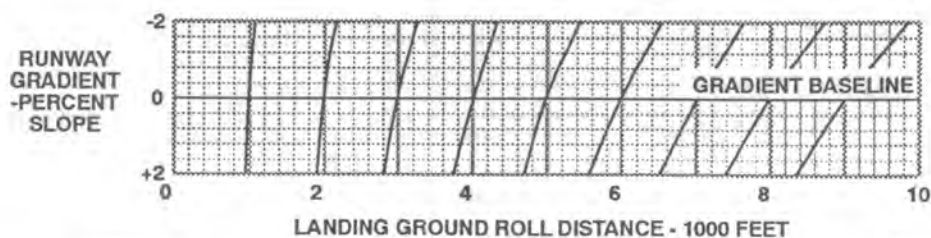
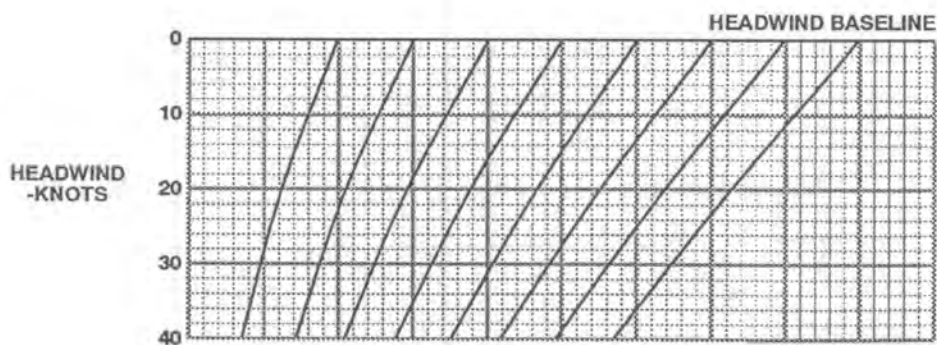
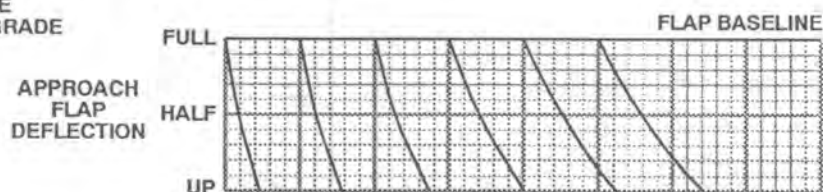
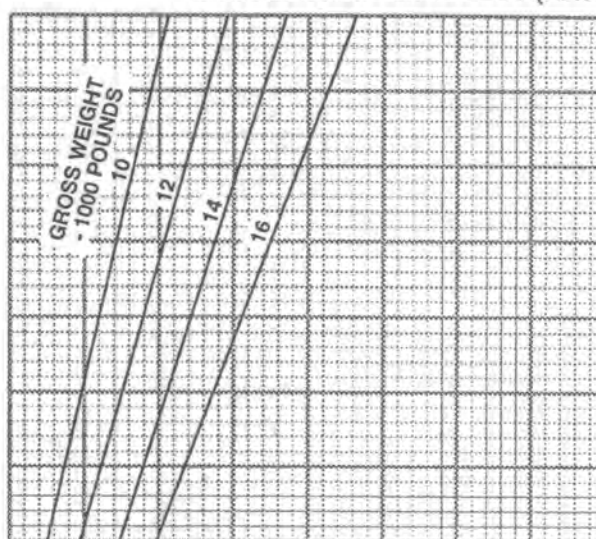
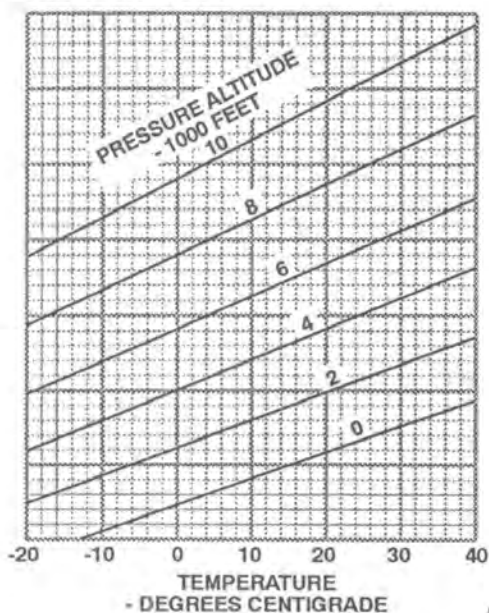
Figure 9-90 Approach Speed TA-4

AL 7(0)

LANDING DISTANCE **HARD SURFACE RUNWAY** **DRY** **SPEEDBRAKES AND SPOILERS OPEN** **RCR = 23**

MODEL: A-4E/F
 ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
 DATA BASIS: FLIGHT TEST (NAVY)



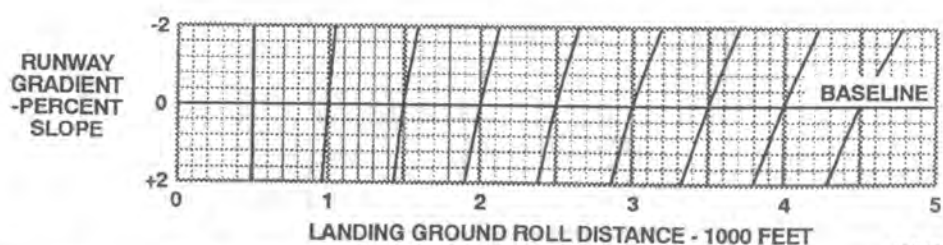
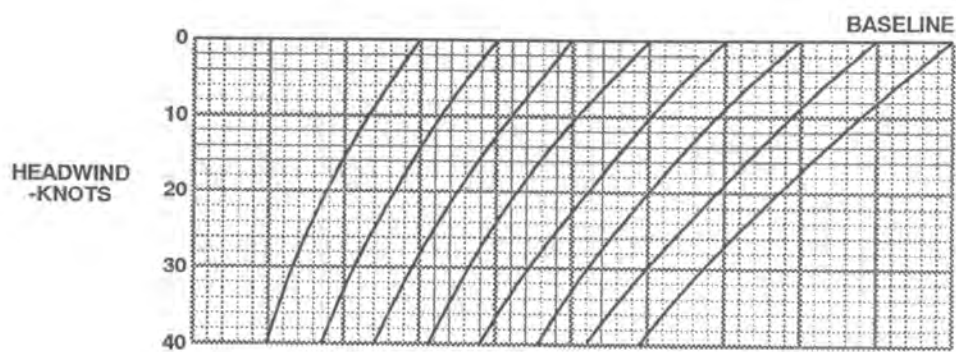
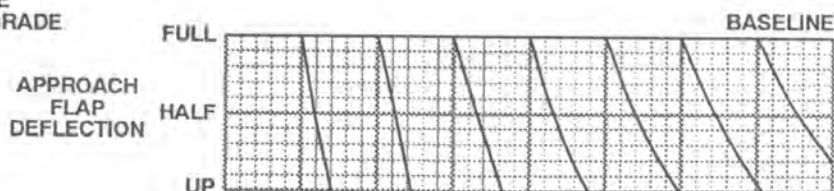
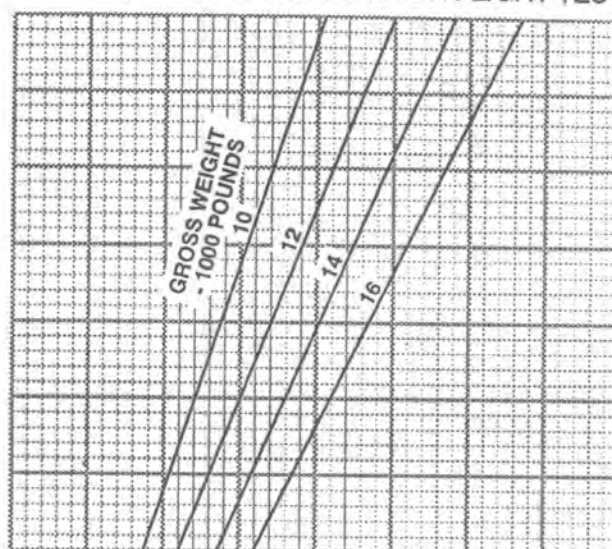
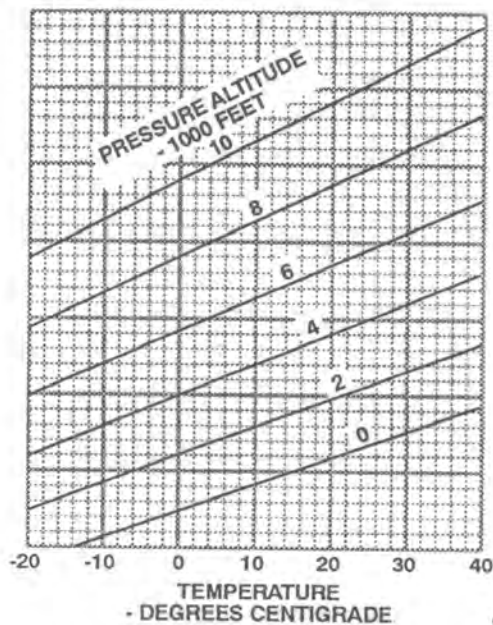
WN1761

Figure 9-91 Landing Distance (Sheet 1 of 11)

AL 7(0)

LANDING DISTANCE

**HARD SURFACE RUNWAY
 DRY
 SPEEDBRAKES AND SPOILERS OPEN
 RCR = 23
 WITH DRAG CHUTE**

MODEL: TA-4K**ENGINE: J52-P-8B/C****DATA AS OF: 15 DECEMBER 1969****DATA BASIS: CONTRACTOR FLIGHT TEST**

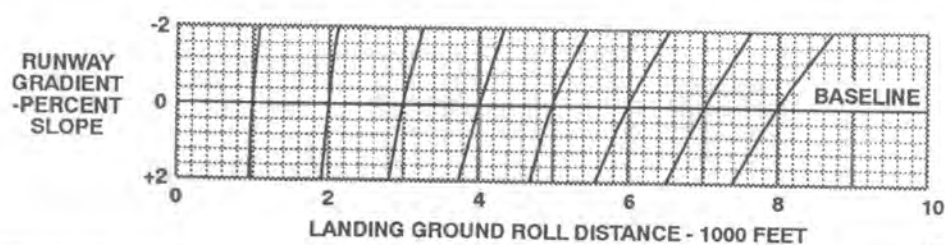
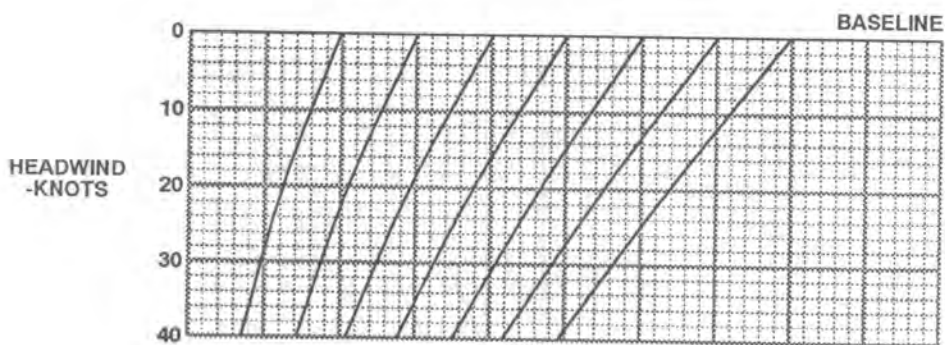
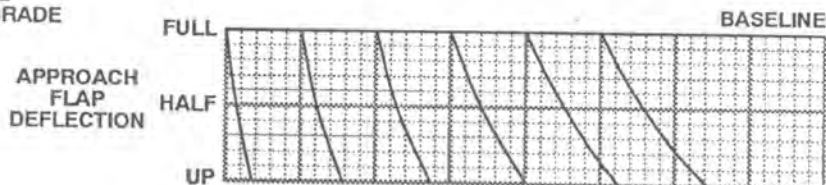
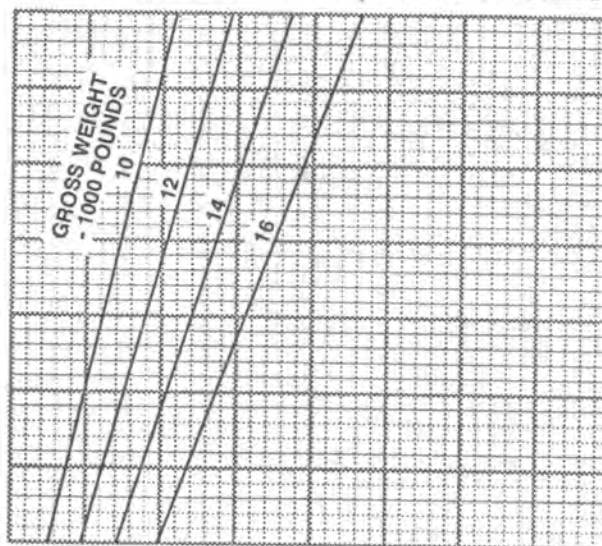
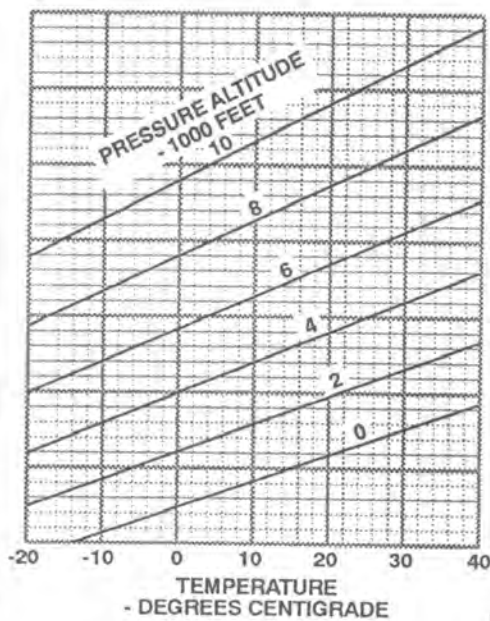
WN1771

Figure 9-91 Landing Distance (Sheet 2 of 11)

LANDING DISTANCE
HARD SURFACE RUNWAY
DRY
SPEEDBRAKES AND SPOILERS OPEN
RCR = 23

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY AND CONTRACTOR)

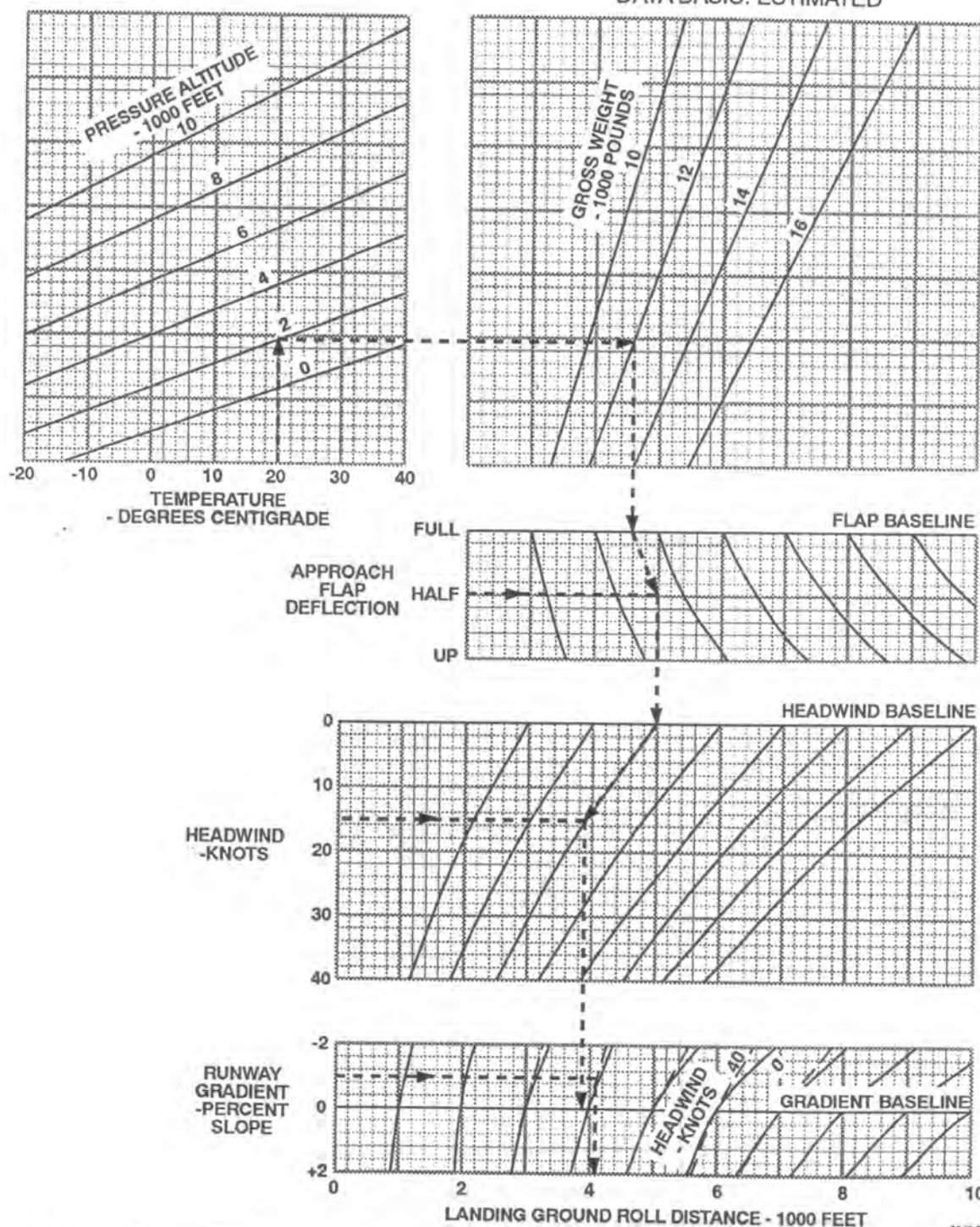


WN1763

Figure 9-91 Landing Distance (Sheet 3 of 11)

AL 7(0)

LANDING DISTANCE
HARD SURFACE RUNWAY
WET
SPEEDBRAKES AND SPOILERS OPEN
RCR = 15

MODEL: A-4E/F**ENGINE: J52-P-8B/C****DATA AS OF: 15 NOVEMBER 1972****DATA BASIS: ESTIMATED**

WN1764

Figure 9-91 Landing Distance (Sheet 4 of 11)

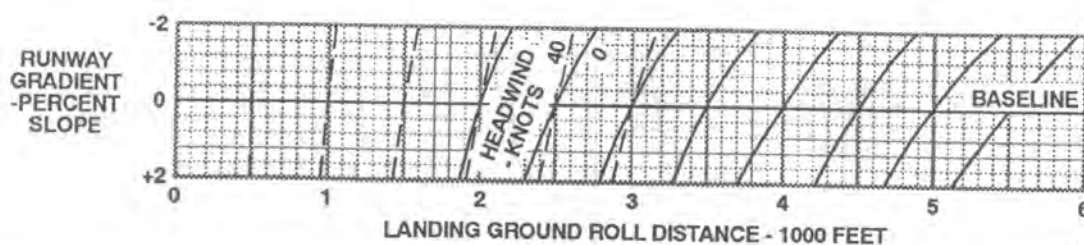
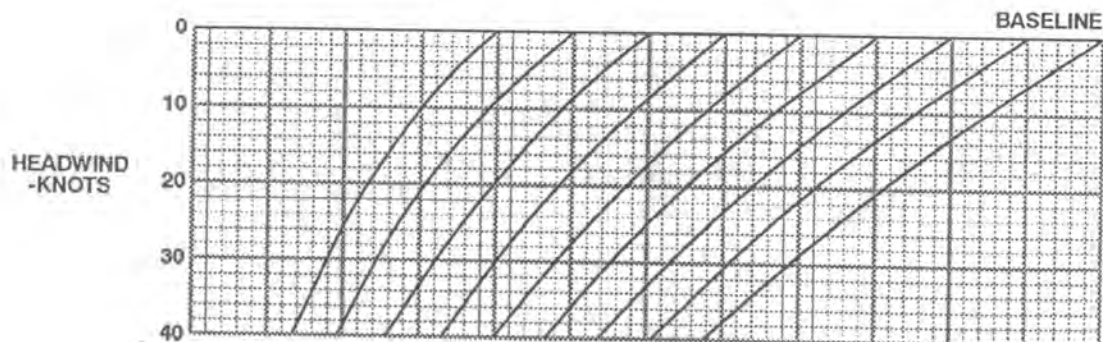
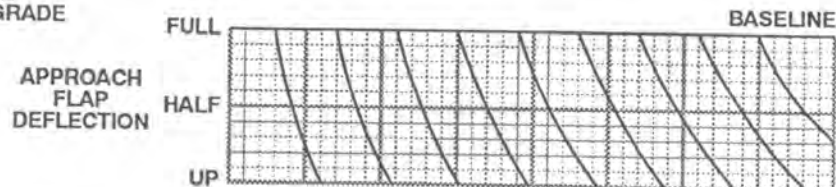
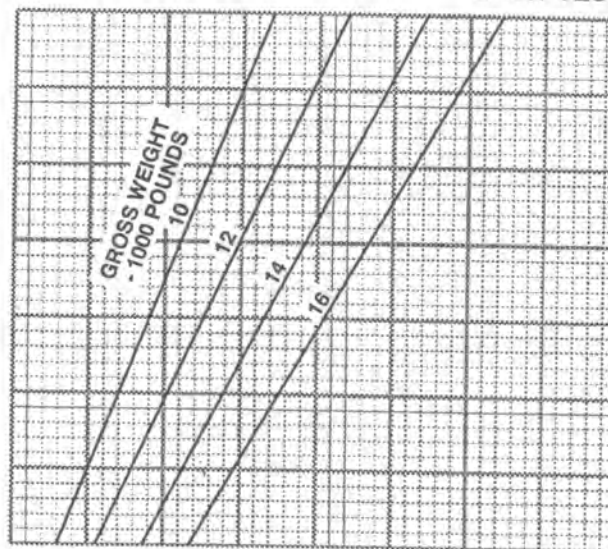
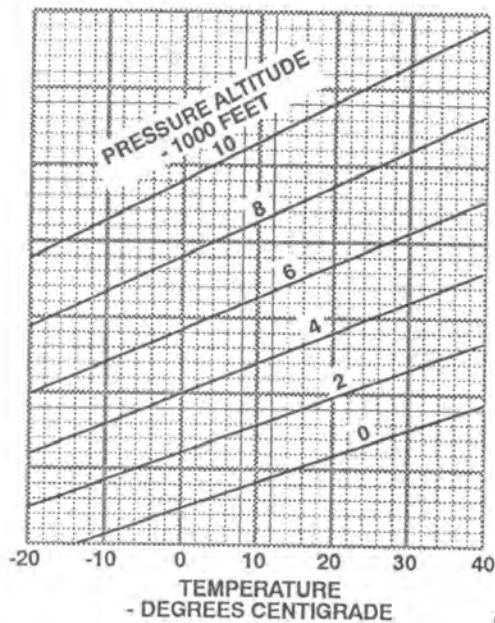
AL 7(0)

LANDING DISTANCE

**HARD SURFACE RUNWAY
WET
SPEEDBRAKES AND SPOILERS OPEN
RCR = 15
WITH DRAG CHUTE**

**MODEL: TA-4K
ENGINE: J52-P-8B/C**

**DATA AS OF: 15 DECEMBER 1972
DATA BASIS: CONTRACTOR FLIGHT TEST**



WN1772

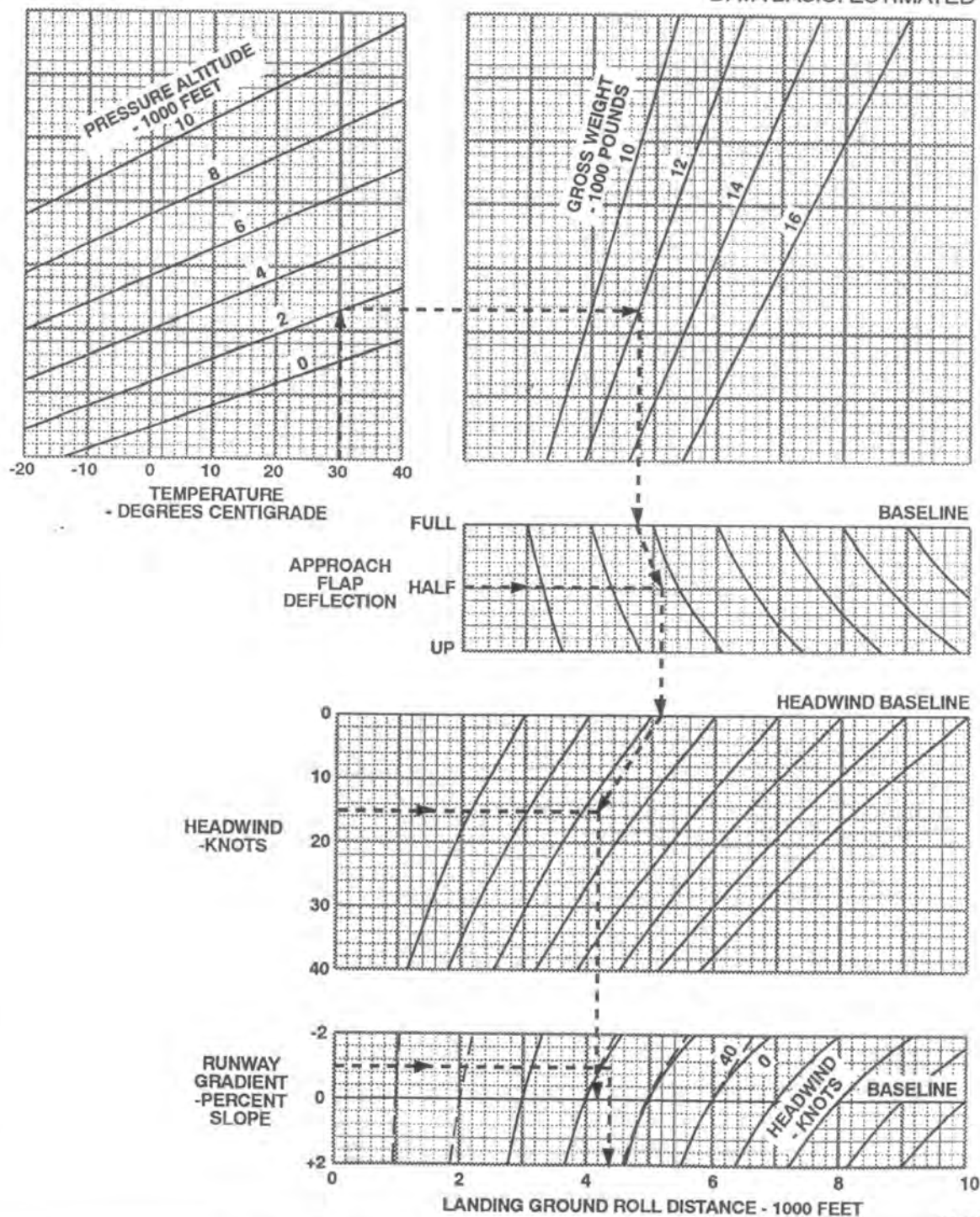
Figure 9-91 Landing Distance (Sheet 5 of 11)

AL 7(0)

LANDING DISTANCE **HARD SURFACE RUNWAY** **WET** **SPEEDBRAKES AND SPOILERS OPEN** **RCR = 15**

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: ESTIMATED



WN1766

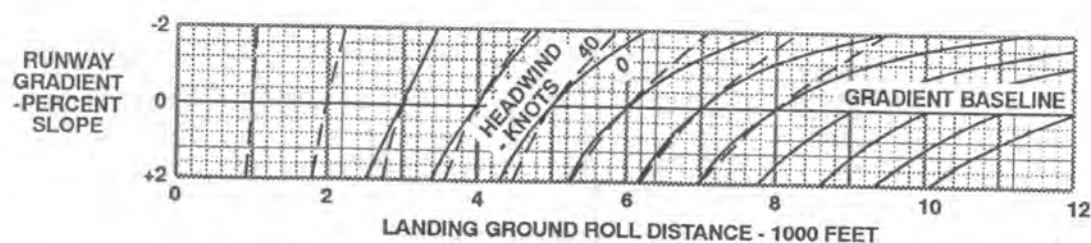
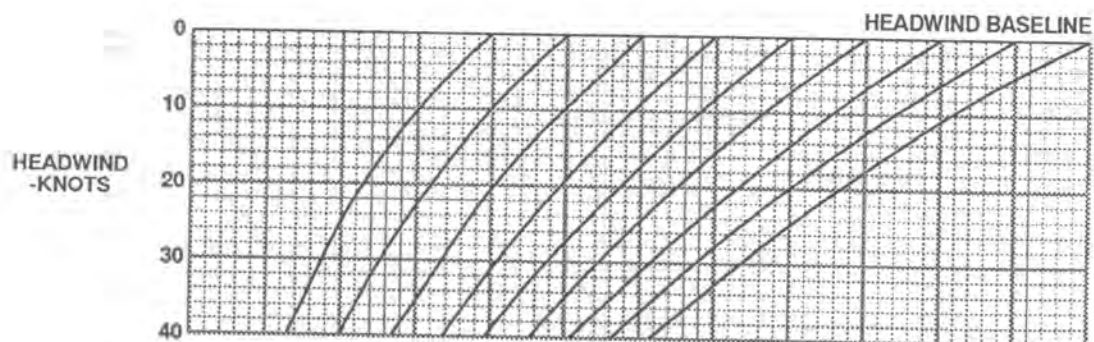
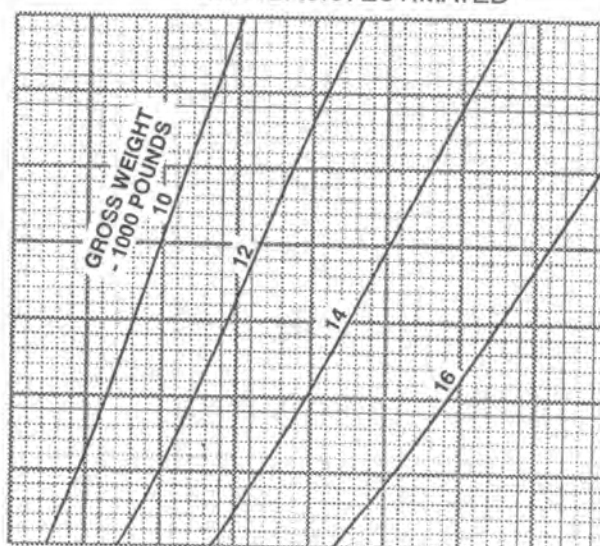
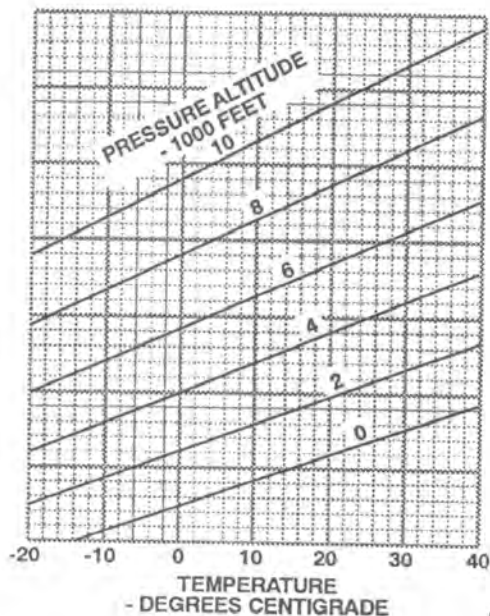
Figure 9-91 Landing Distance (Sheet 6 of 11)

LANDING DISTANCE

HARD SURFACE RUNWAY
SNOW AND ICE
SPEEDBRAKES AND SPOILERS OPEN
RCR = 9

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: ESTIMATED



WN1765

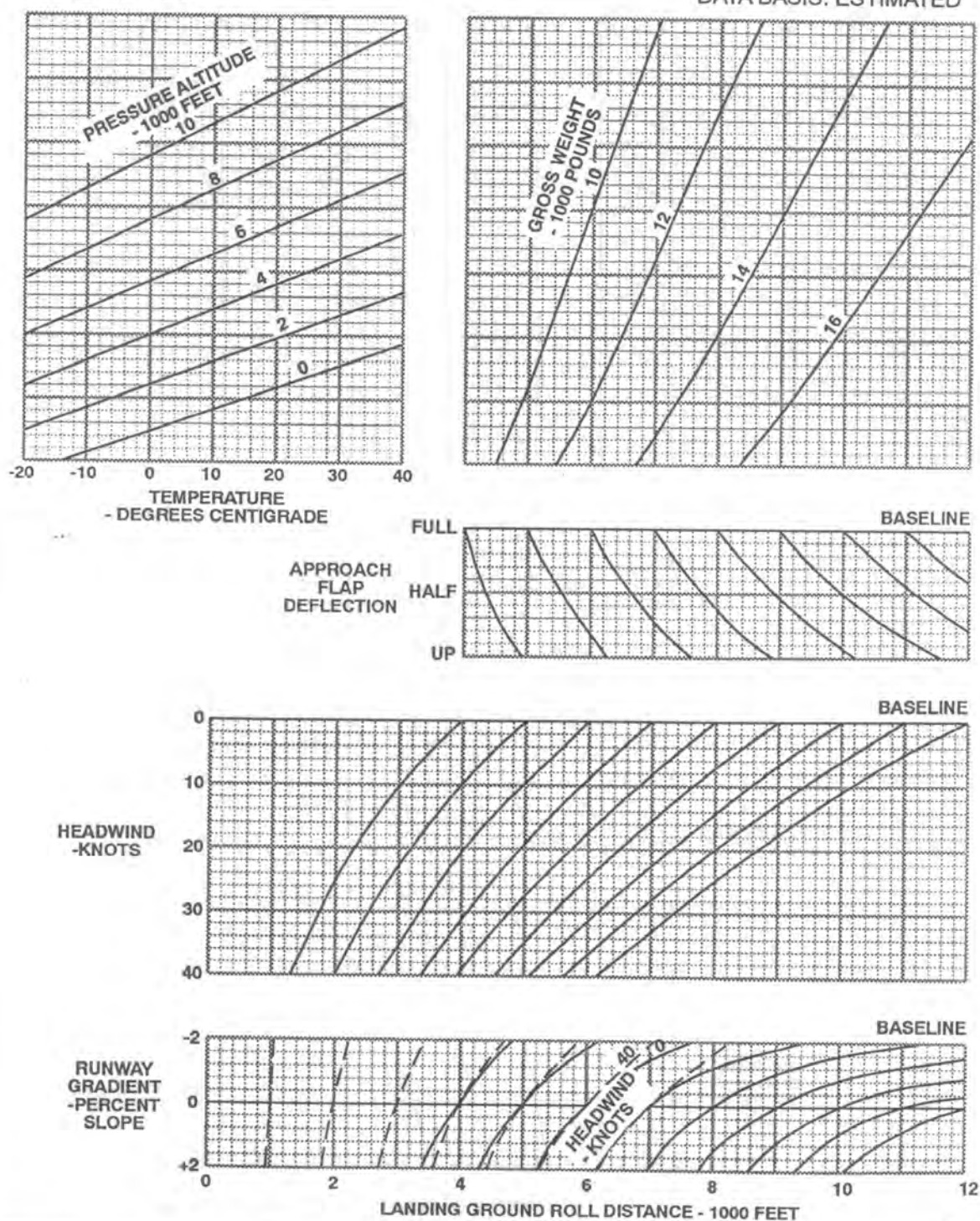
Figure 9-91 Landing Distance (Sheet 7 of 11)

AL 7(0)

LANDING DISTANCE **HARD SURFACE RUNWAY** **SNOW AND ICE** **SPEEDBRAKES AND SPOILERS OPEN** **RCR = 9**

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: ESTIMATED



WN1767

Figure 9-91 Landing Distance (Sheet 8 of 11)

LANDING DISTANCE
HARD SURFACE RUNWAY
DRY
SPEEDBRAKES OPEN
NO SPOILERS OR SPOILERS INOPERATIVE
RCR = 23

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: FLIGHT TEST (NAVY)

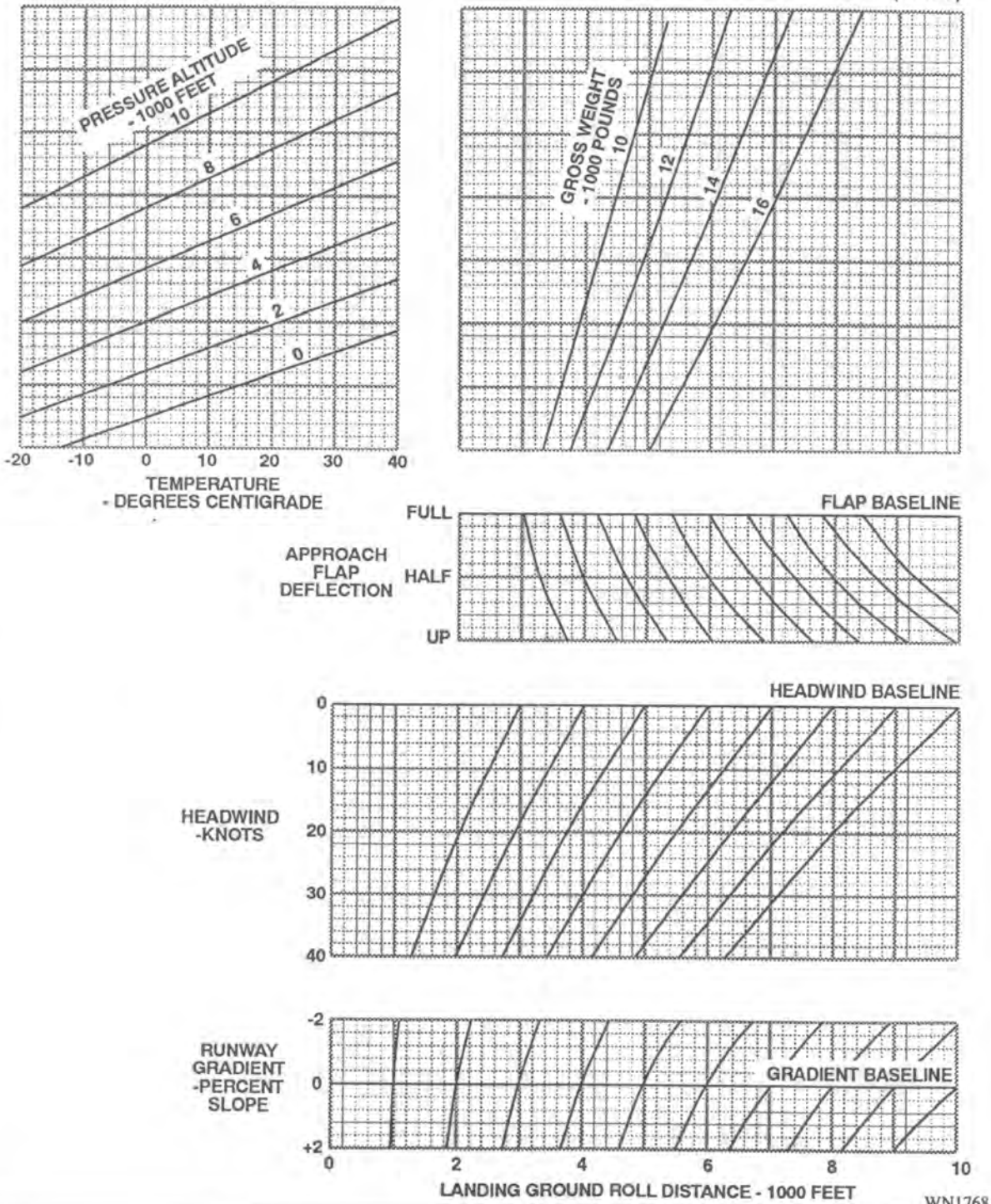


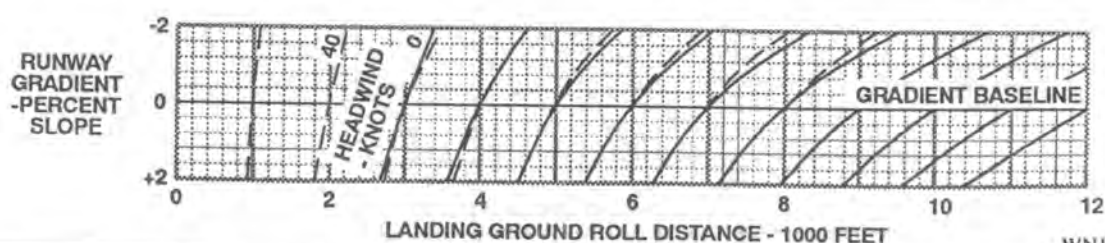
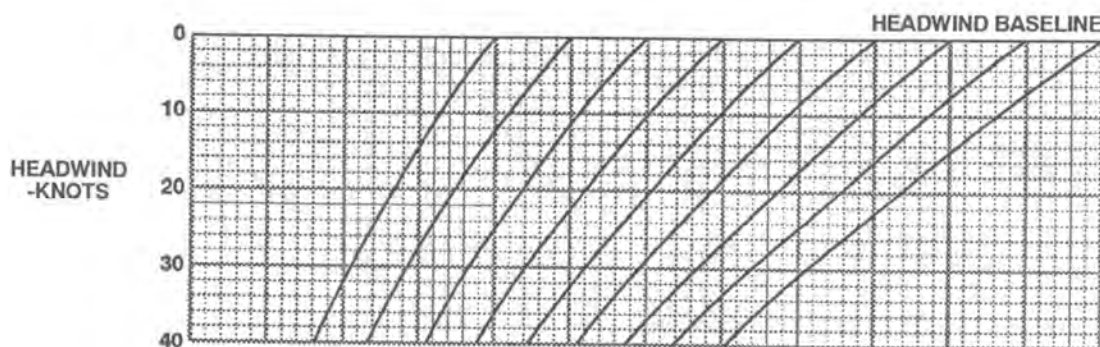
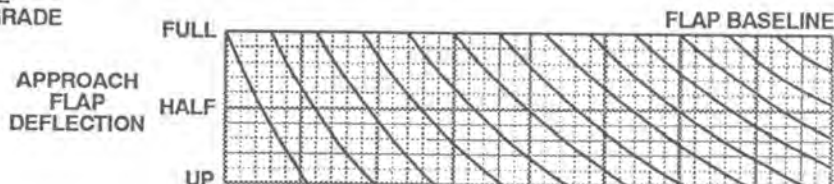
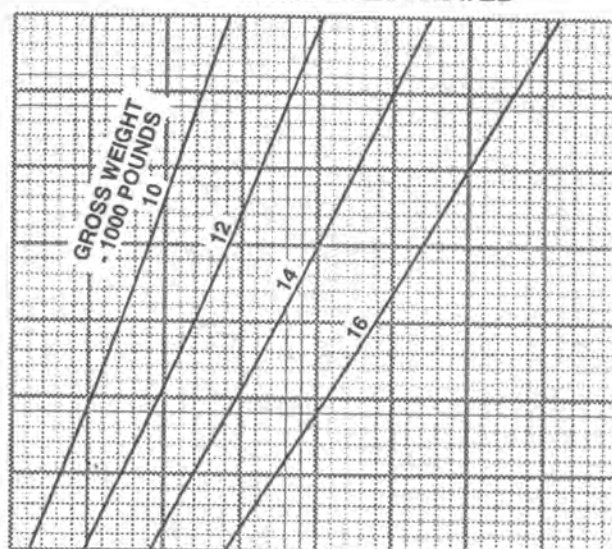
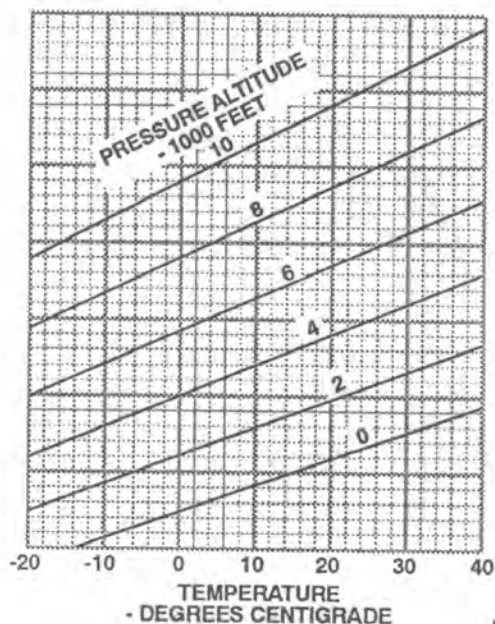
Figure 9-91 Landing Distance (Sheet 9 of 11)

AL 7(0)

LANDING DISTANCE **HARD SURFACE RUNWAY** **WET** **SPEEDBRAKES OPEN** **NO SPOILERS OR SPOILERS INOPERATIVE** **RCR = 15**

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: ESTIMATED



WN1769

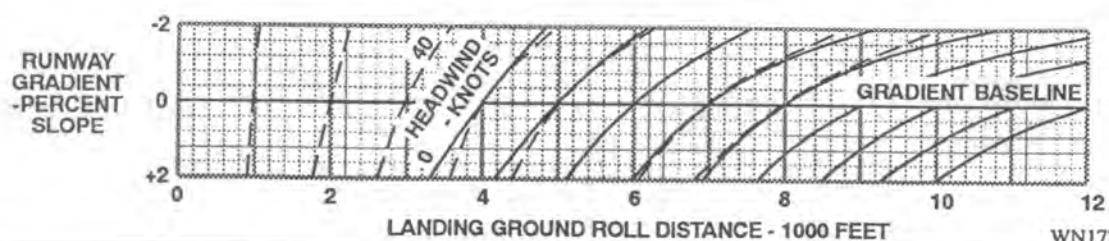
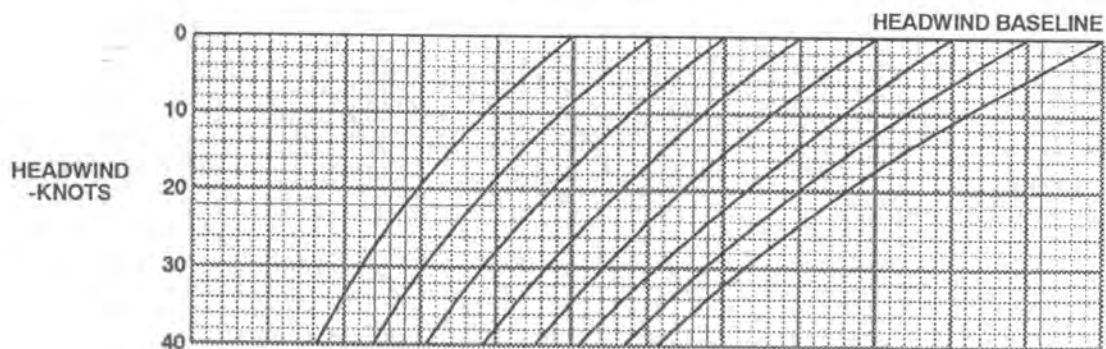
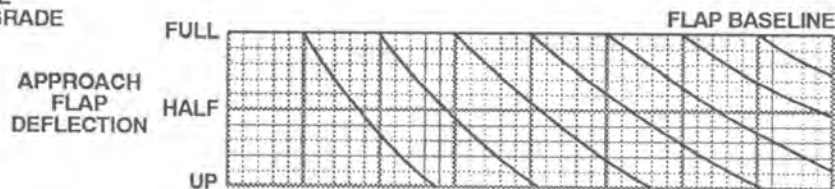
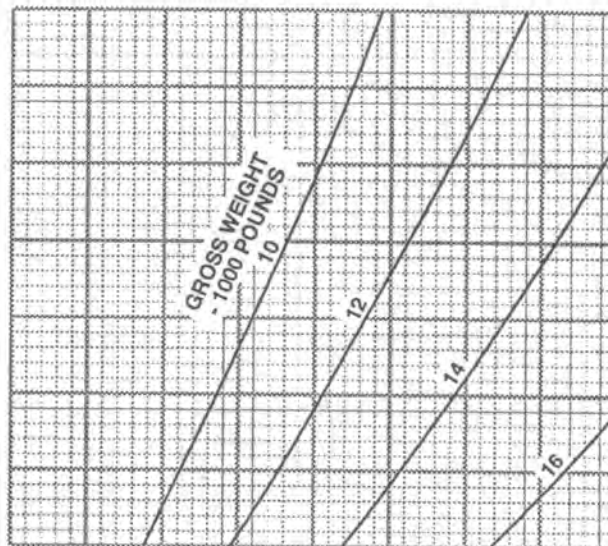
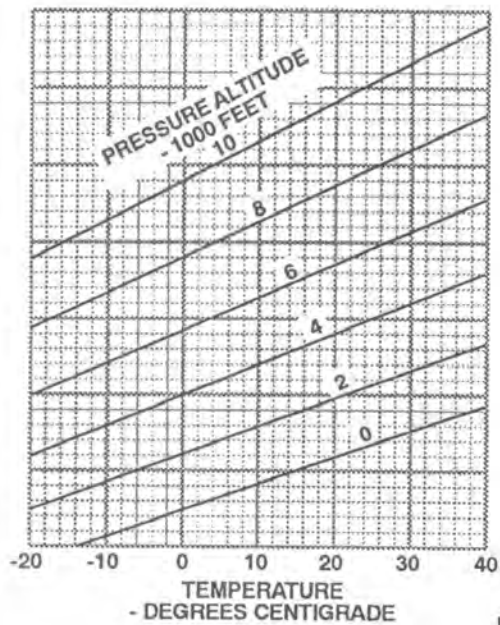
Figure 9-91 Landing Distance (Sheet 10 of 11)

LANDING DISTANCE

**HARD SURFACE RUNWAY
SNOW AND ICE
SPEEDBRAKES OPEN
NO SPOILERS OR SPOILERS INOPERATIVE
RCR = 9**

MODEL: A-4E/F
ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
DATA BASIS: ESTIMATED



WN1770

Figure 9-91 Landing Distance (Sheet 11 of 11)

COMBAT PERFORMANCE

COMBAT PERFORMANCE

9.61 This part contains the performance charts associated with the combat phase of the mission. Maximum Mach number and turning radius data are included.

TURNING RADIUS

9.62 The turning radius nomograph, Figure 9-96, present data for steady state level turns as a function of true airspeed, normal load factor, bank angle, distance travelled, and heading change. When used in conjunction with the load factor limitations of the manoeuvrability charts, Figure 9-97, the aerodynamic, engine, and structural characteristics of the aircraft are taken into account.

SAMPLE PROBLEM

Turning Radius

(For Figure 9-96)

9.63 From Manoeuvrability Sample Problem 1 (Figure 9-97)

Mach Number 0.75

Normal Load Factor 3.25

(A) Normal Load Factor 3.25
(Bank Angle 72°)

(B) True Airspeed 496 KIAS
(From Figure 9-5)

(C) Turning Radius 7100 ft

(D) Heading change 90°

(E) Distance Travelled in Turn 11,000 ft

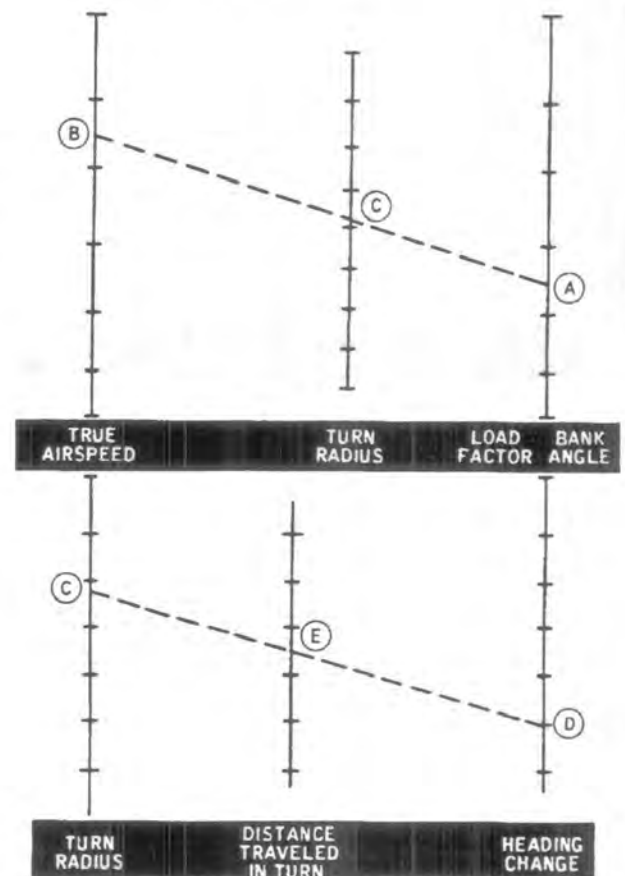


Figure 9-92 Sample Turning Radius

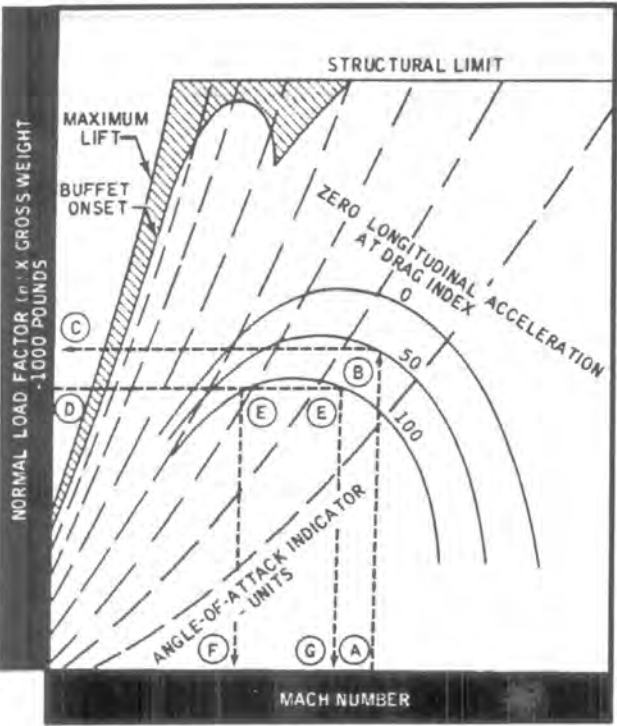


Figure 9-93 Sample Manoeuvrability

MANOEUVRABILITY

9.64 Low altitude manoeuvreability characteristics of A-4E/F aircraft are shown in Figure 9-97. These data provide a means of determining either the maximum load factor attainable at a specified Mach number (sample problem 1) or the maximum (and minimum) Mach number for a predetermined load factor requirement (sample problem 2). These data are presented as a function of altitude, weight-times-load factor, Mach number, drag index, and angle-of-attack for zero longitudinal acceleration. Superimposed on the graphs are lines showing maximum lift, buffet onset, and structural limit. All data presented are based on the engine developing military thrust.

SAMPLE PROBLEM 1

Manoeuvrability

(For Figure 9-97, sheet 1)

- Altitude Sea level
- Gross weight 18,000 lb
- (A) Mach number 0.75
- (B) Drag index 50
- (C) Normal load factor
x gross weight 58,700 lb

Gross weight 18,000 lb

Normal load factor at zero
longitudinal acceleration 3.26g

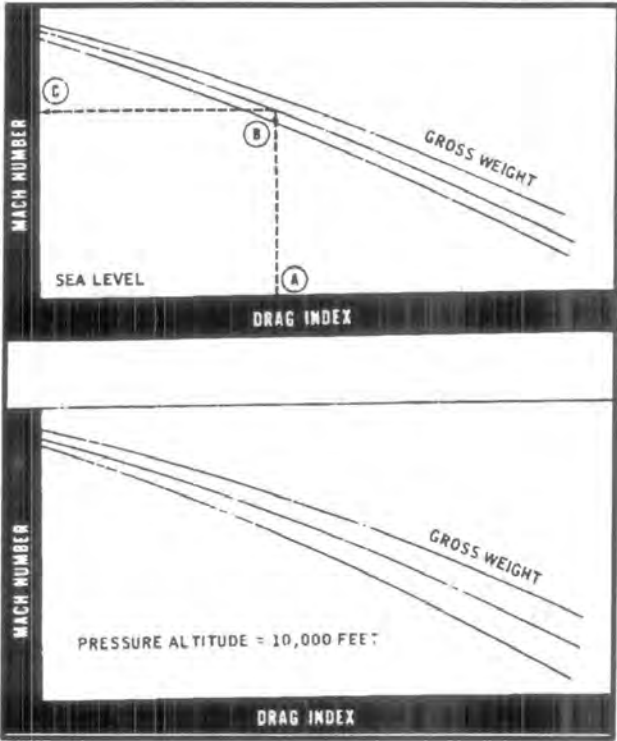


Figure 9-94 Sample Maximum Mach Number

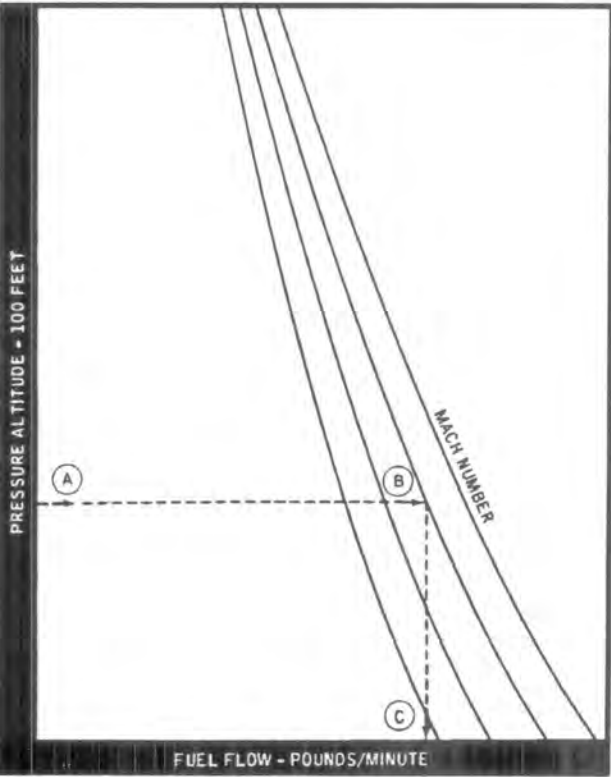


Figure 9-95 Sample Military Fuel Flow

SAMPLE PROBLEM 2

Manoeuvrability

(For Figure 9-97, sheet 1)

- (A) Altitude sea level
- (B) Gross weight 20,000 lb
- (C) Normal load factor required 2.5g
- (D) Normal load factor x gross weight. 50,000 lb
- (E) Drag index 100
- (F) Minimum Mach number at 2.5g 0.392
- (G) Maximum Mach number at 2.5g 0.722

MAXIMUM MACH NUMBER

9.65 Level flight maximum Mach number, at military thrust, is shown in Figure 9-98 as a function of drag index

and gross weight at altitudes of sea level and 10,000 feet. Corresponding fuel flow data is shown on Figure 9-99 and Figure 9-100.

SAMPLE PROBLEM

Maximum Mach Number

(For Figure 9-98)

- (A) Drag index 60
- (B) Gross weight at sea level 18,000 lb
- (C) Mach number 0.82

SAMPLE PROBLEM

Military Fuel Flow

(For Figure 9-99)

- (A) Pressure altitude 10,000 ft
- (B) Mach number 0.80
- (C.) Fuel flow 118 lb/min

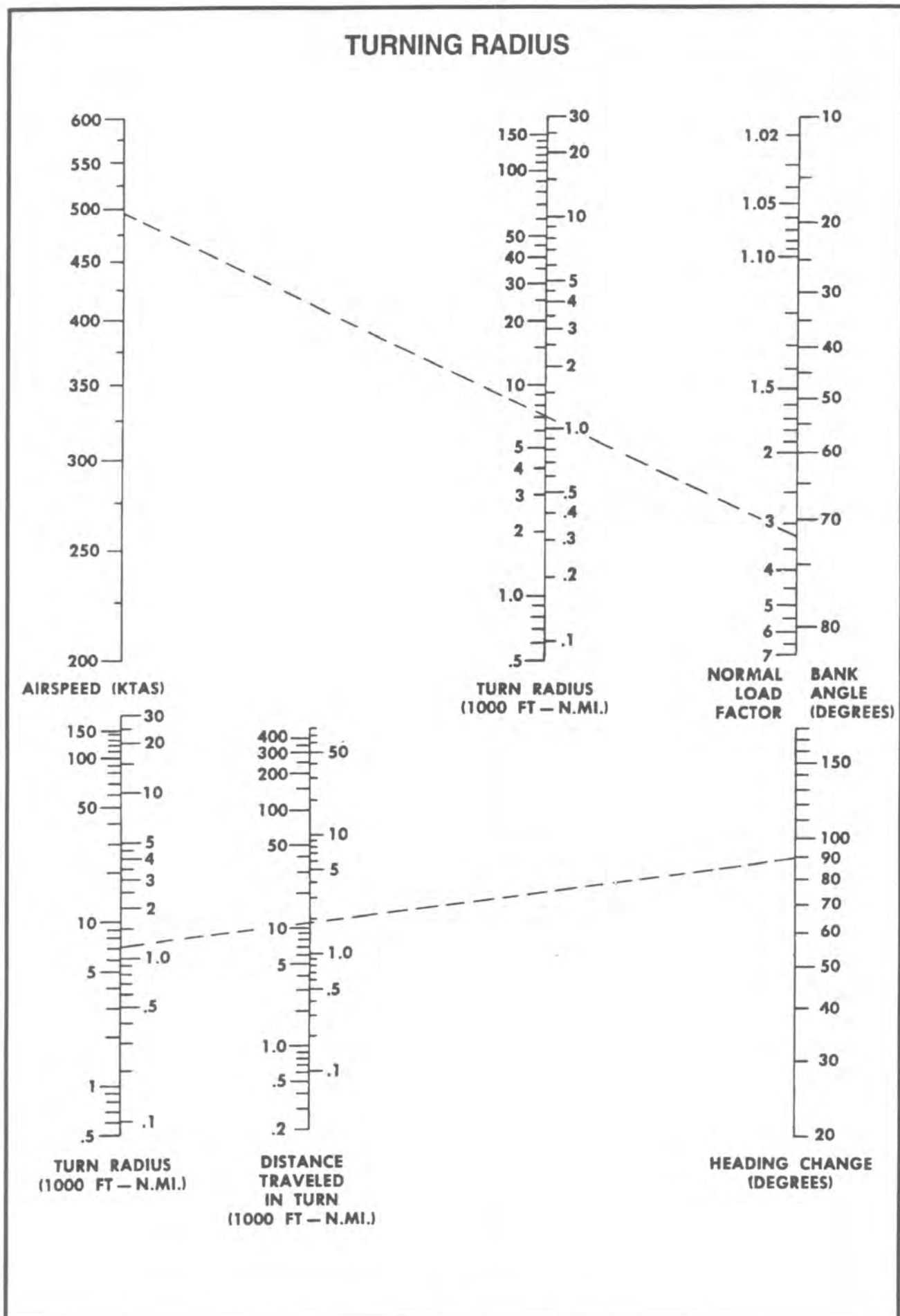


Figure 9-96 Turning Radius

AL 7(0)

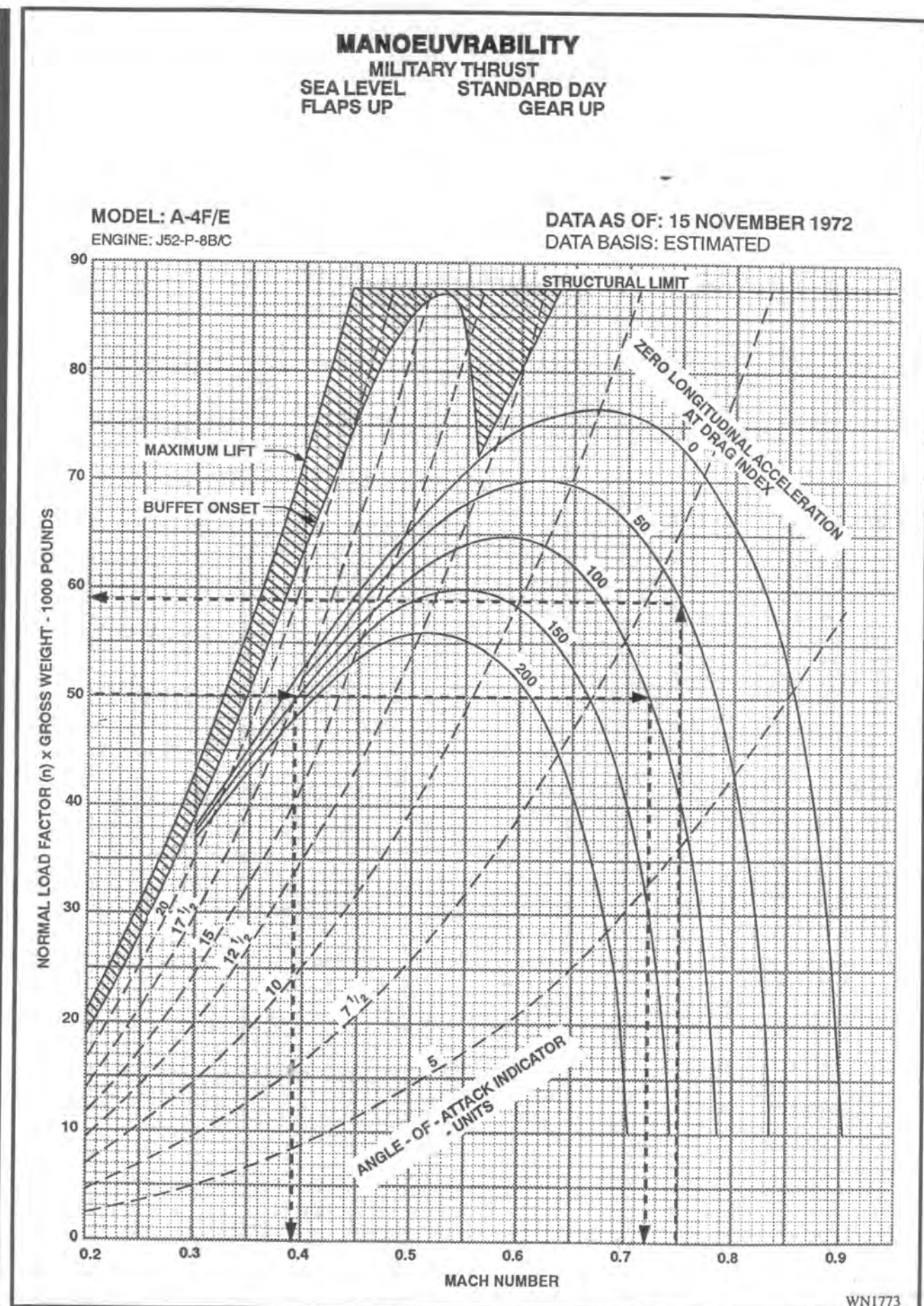


Figure 9-97 Manoeuvrability (Sheet 1 of 5)

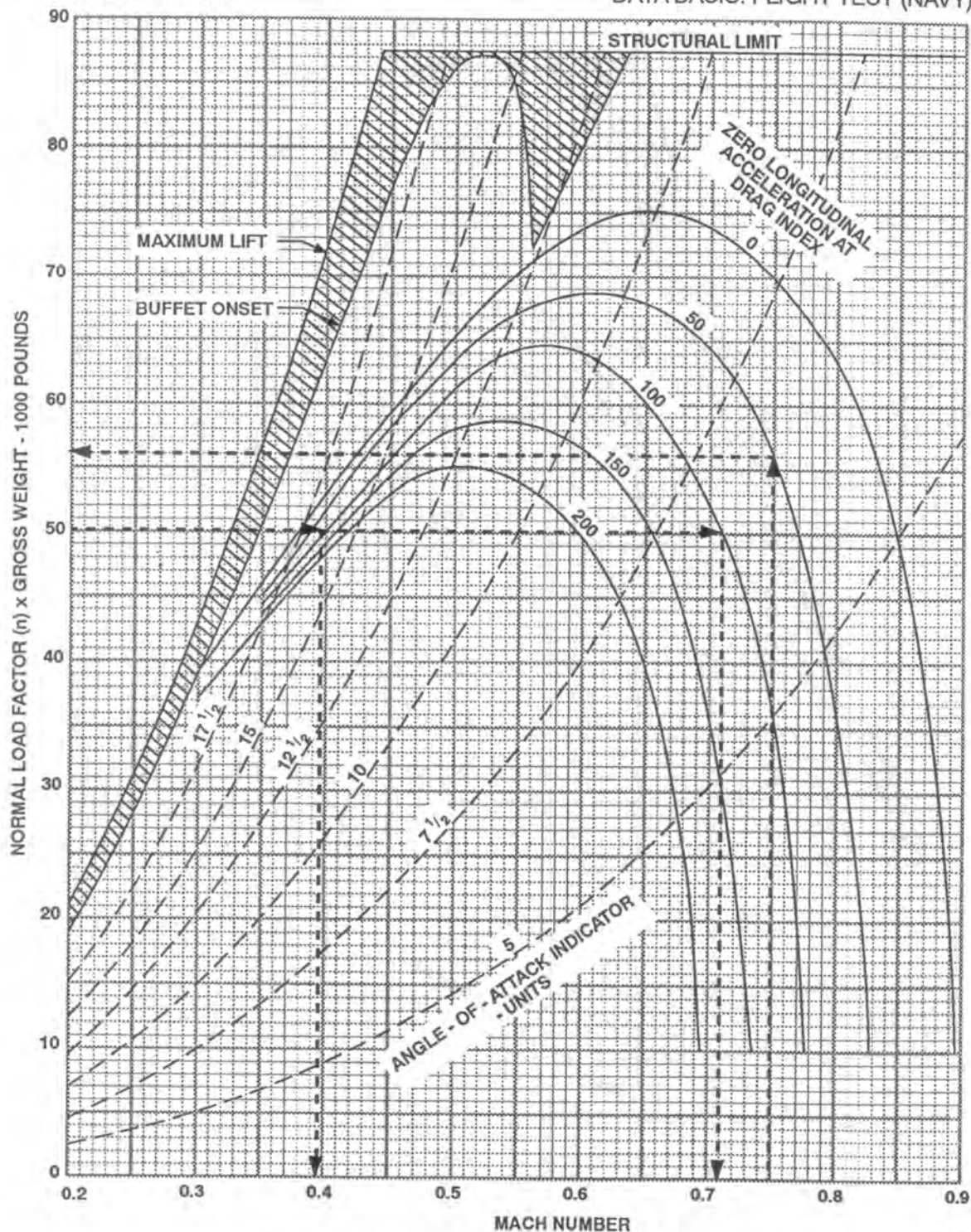
MANOEUVRABILITY MILITARY THRUST SEA LEVEL - STANDARD DAY

FLAPS UP

GEAR UP

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1775

Figure 9-97 Manoeuvrability (Sheet 2 of 5)

AL 7(0)

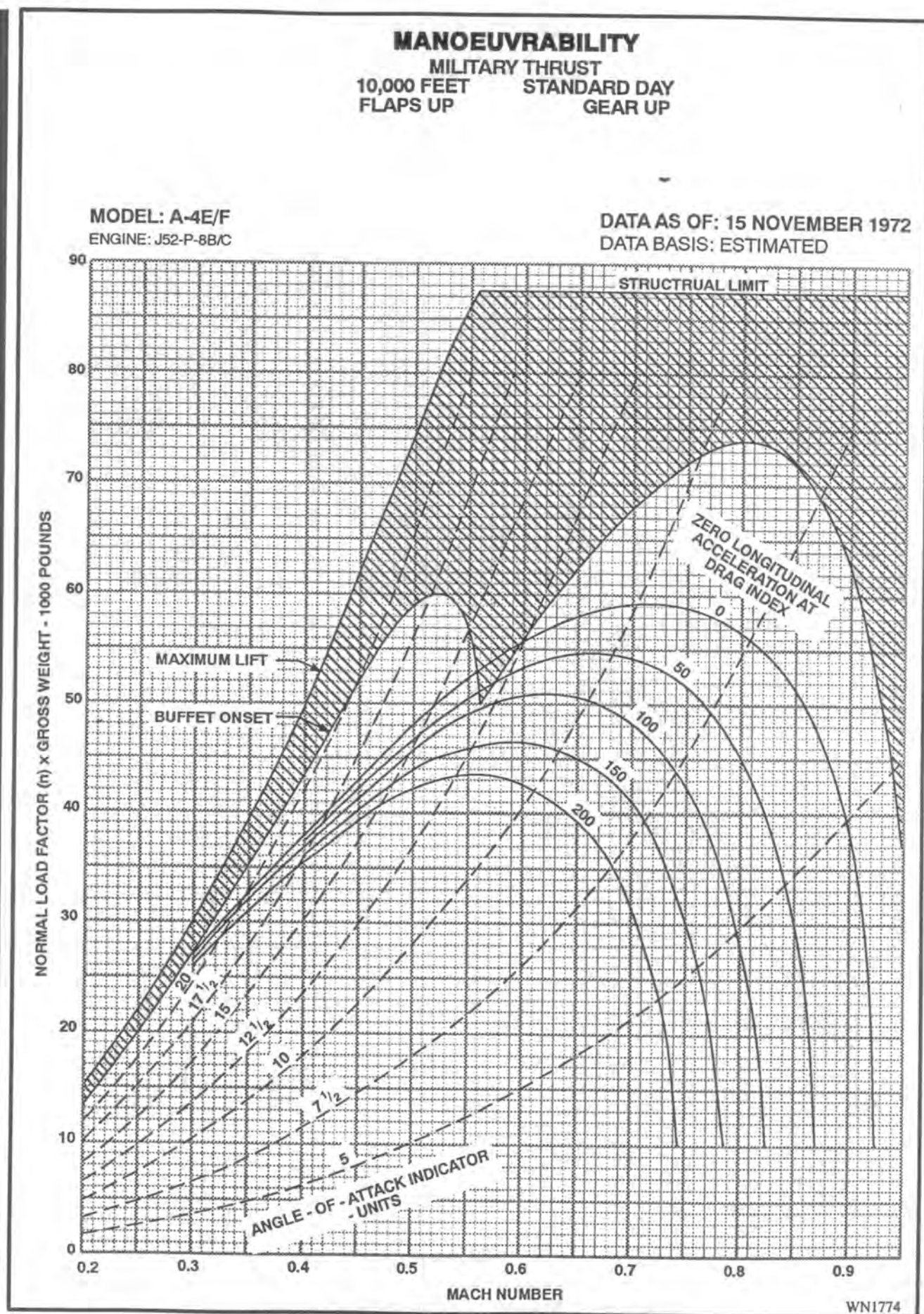


Figure 9-97 Manoeuvrability (Sheet 3 of 5)

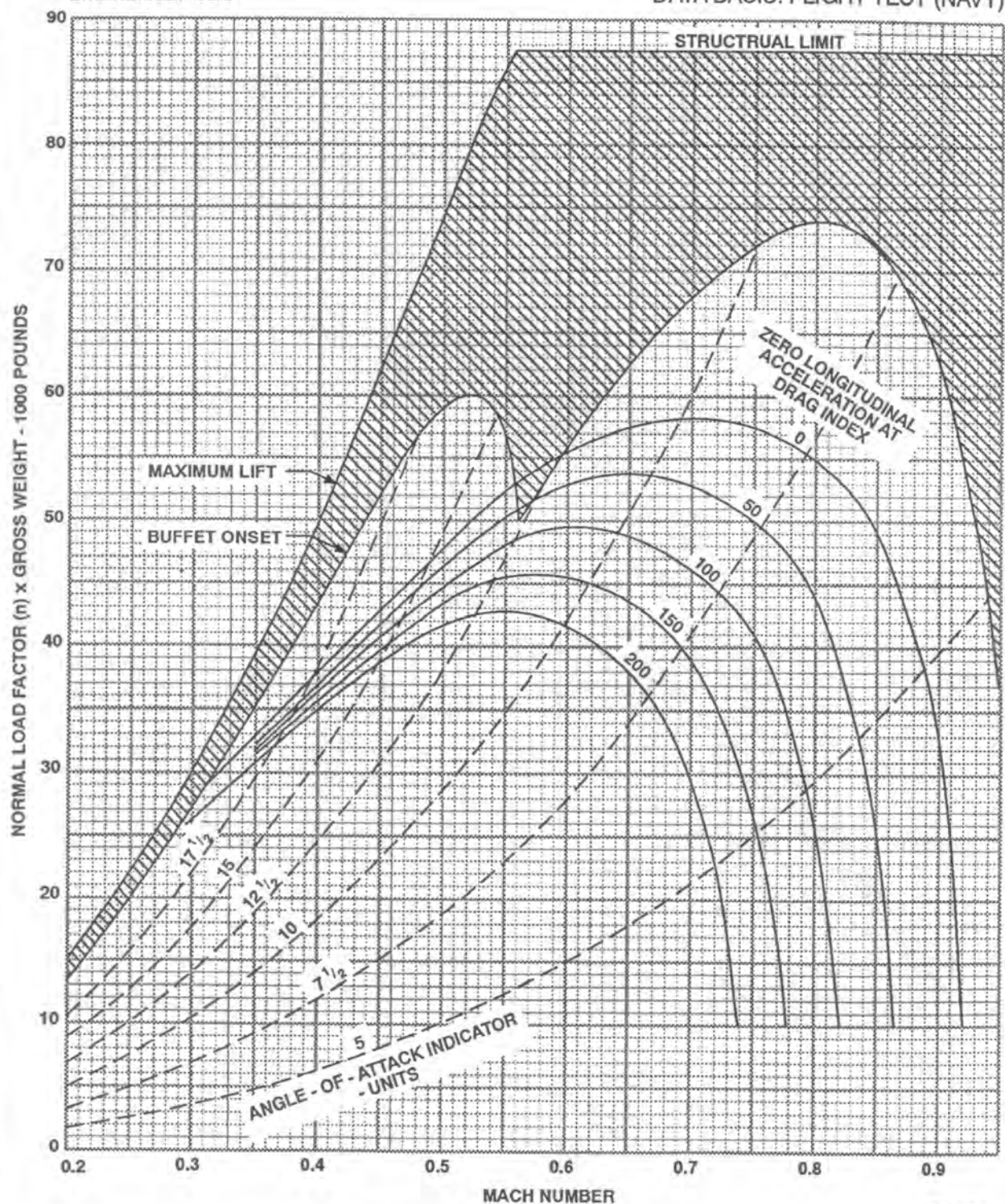
MANOEUVRABILITY **MILITARY THRUST** **10,000 FEET - STANDARD DAY**

GEAR UP

FLAPS UP

MODEL: TA-4F
 ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
 DATA BASIS: FLIGHT TEST (NAVY)



WN1776

Figure 9-97 Manoeuvrability (Sheet 4 of 5)

AL 7(0)

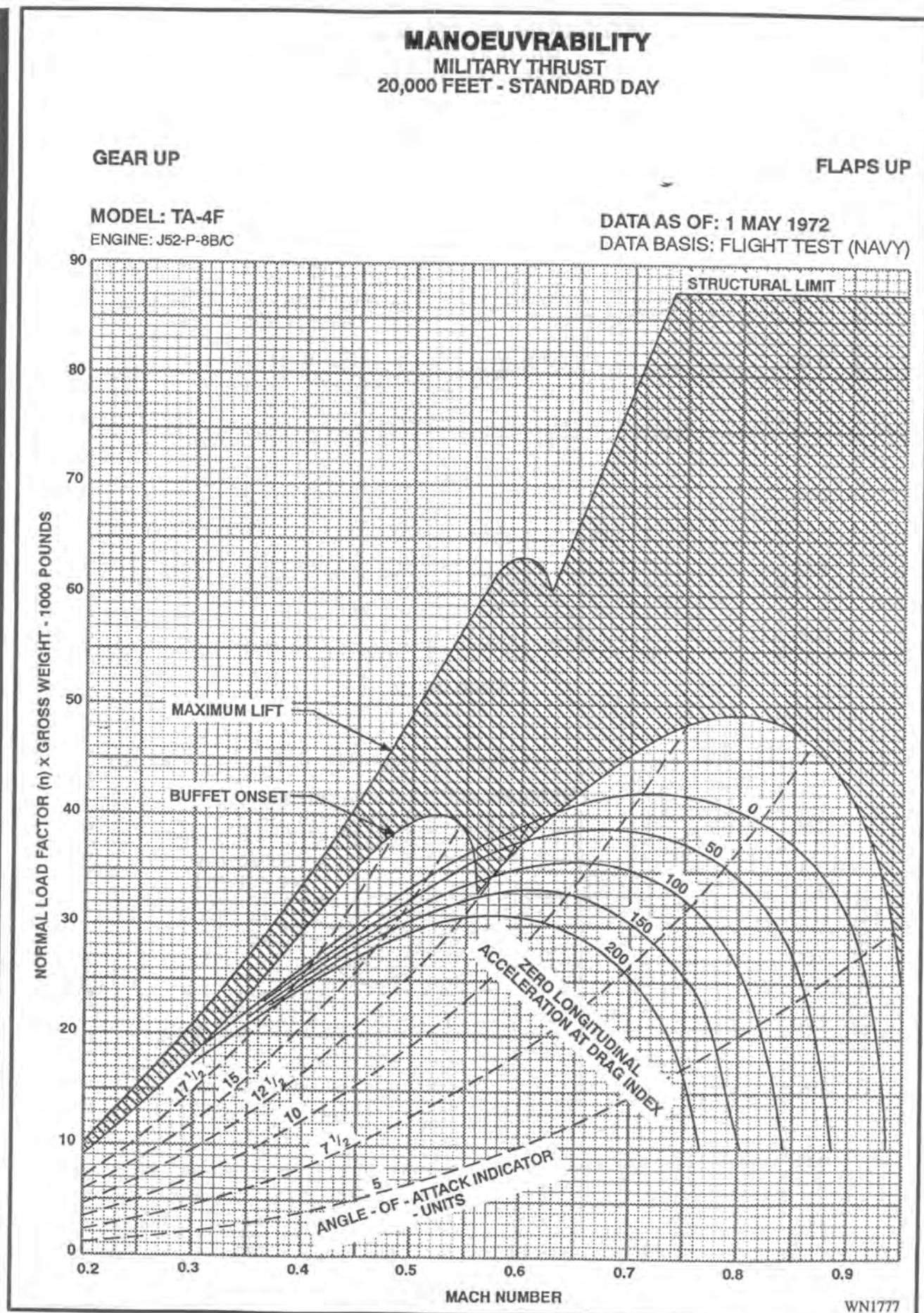
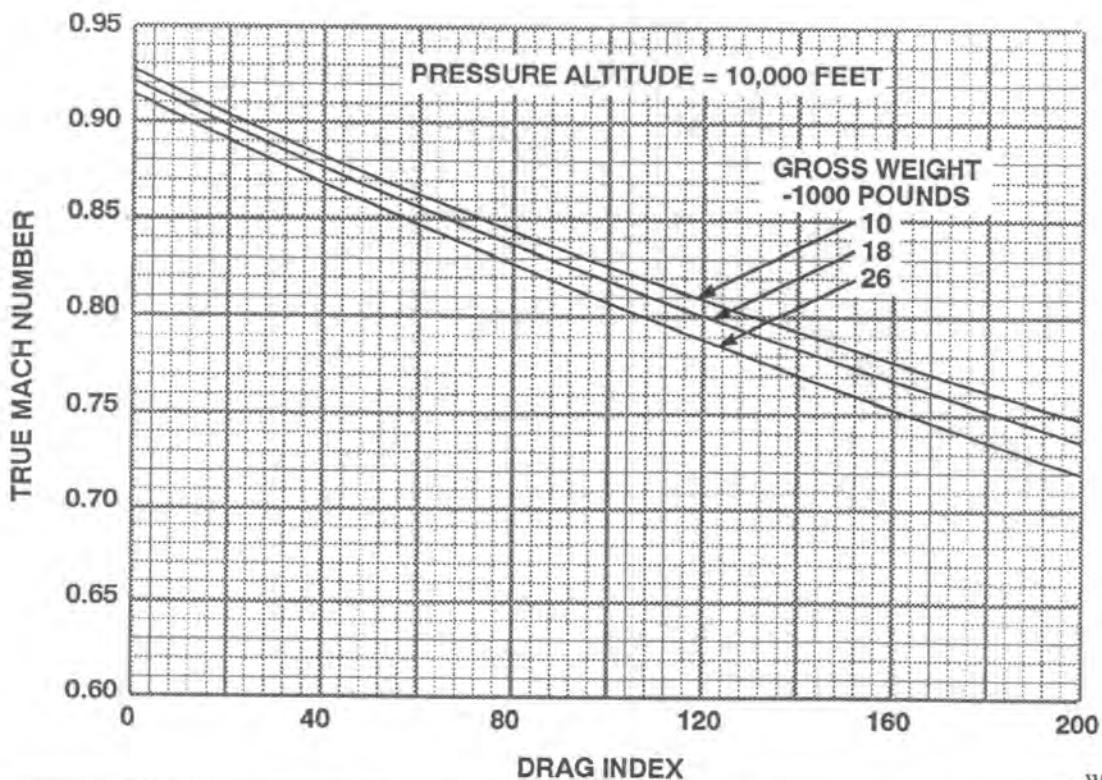
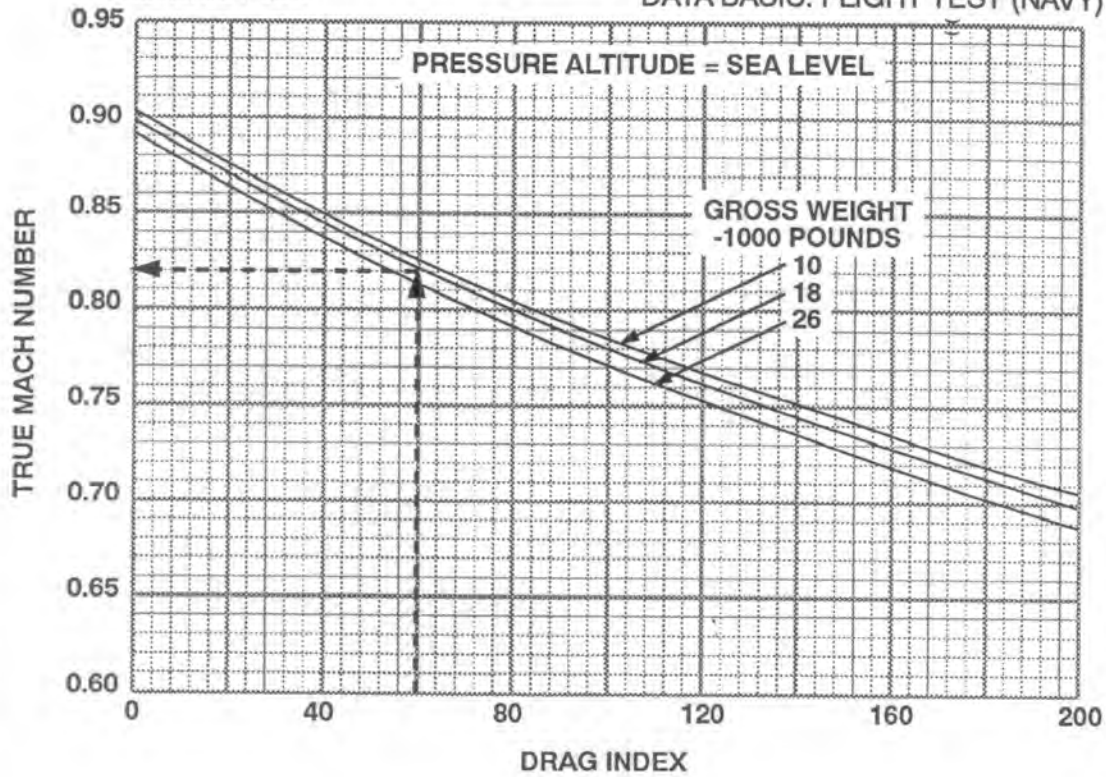


Figure 9-97 Manoeuvrability (Sheet 5 of 5)

MAXIMUM MACH NUMBER **MILITARY THRUST** **ICAO STANDARD ATMOSPHERE**

MODEL: A-4E/F
 ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972
 DATA BASIS: FLIGHT TEST (NAVY)



WN1779

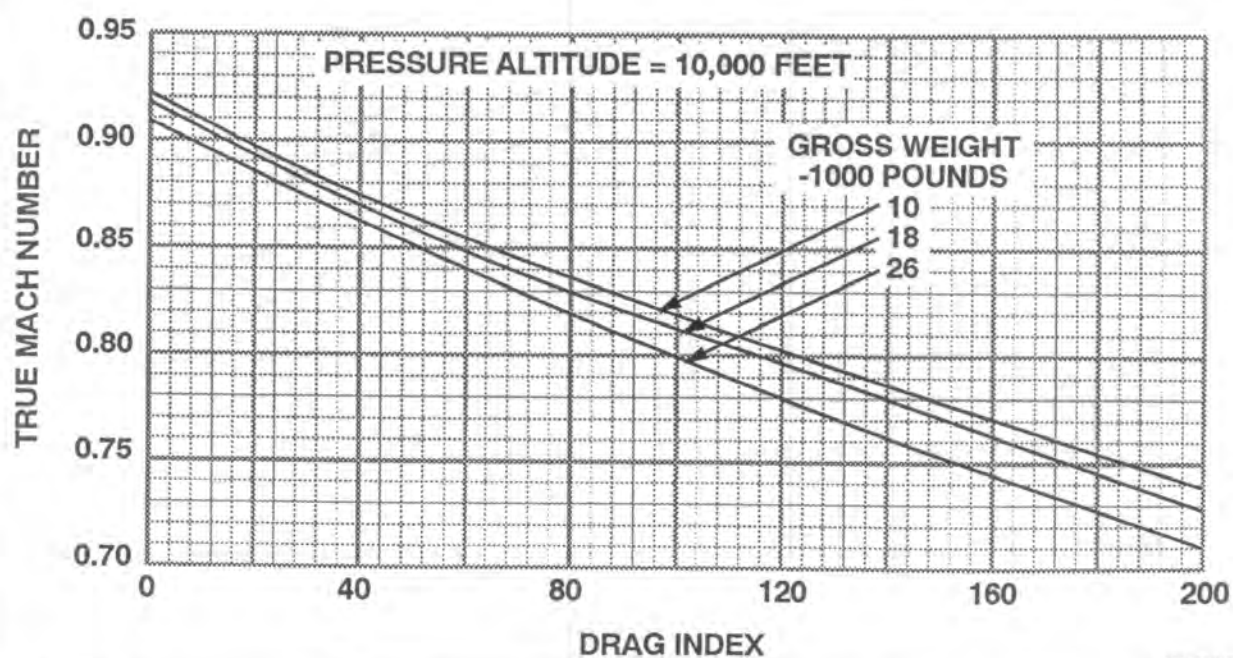
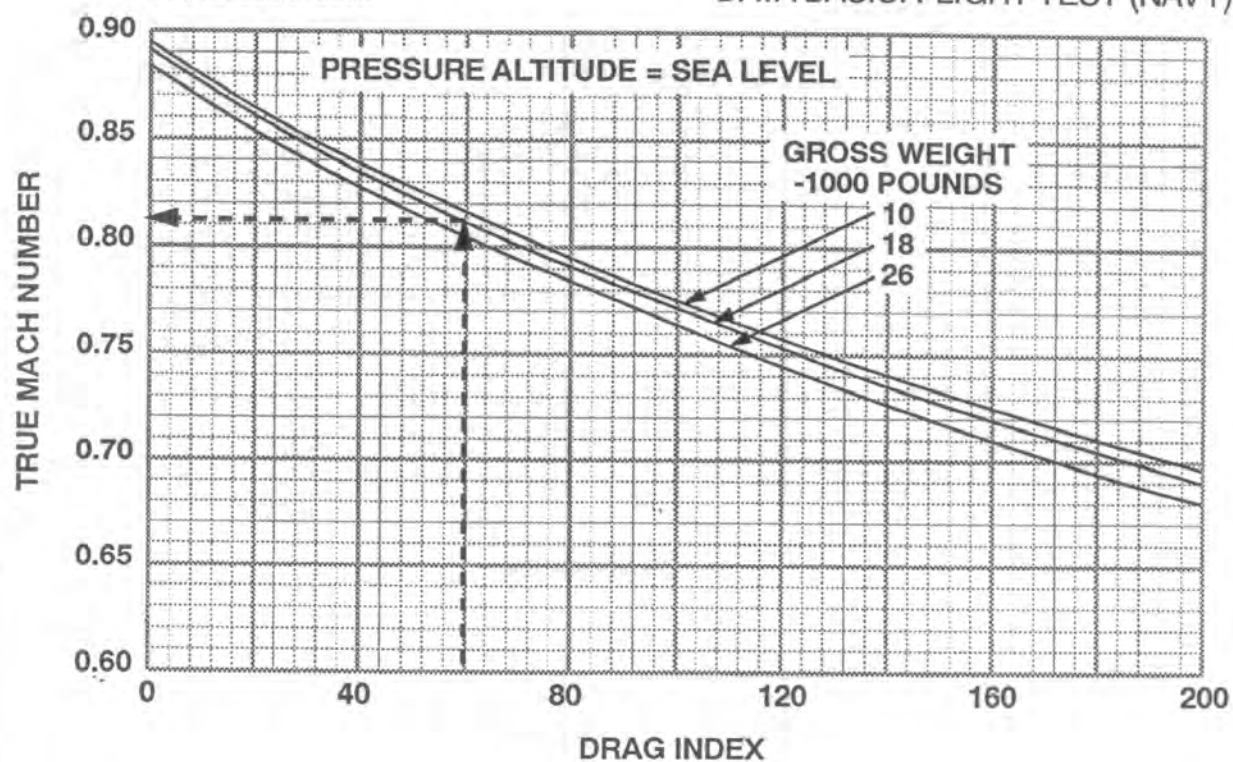
Figure 9-98 Maximum Mach Number (Sheet 1 of 3)

AL 7(0)

MAXIMUM MACH NUMBER **MILITARY THRUST** **ICAO STANDARD ATMOSPHERE**

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



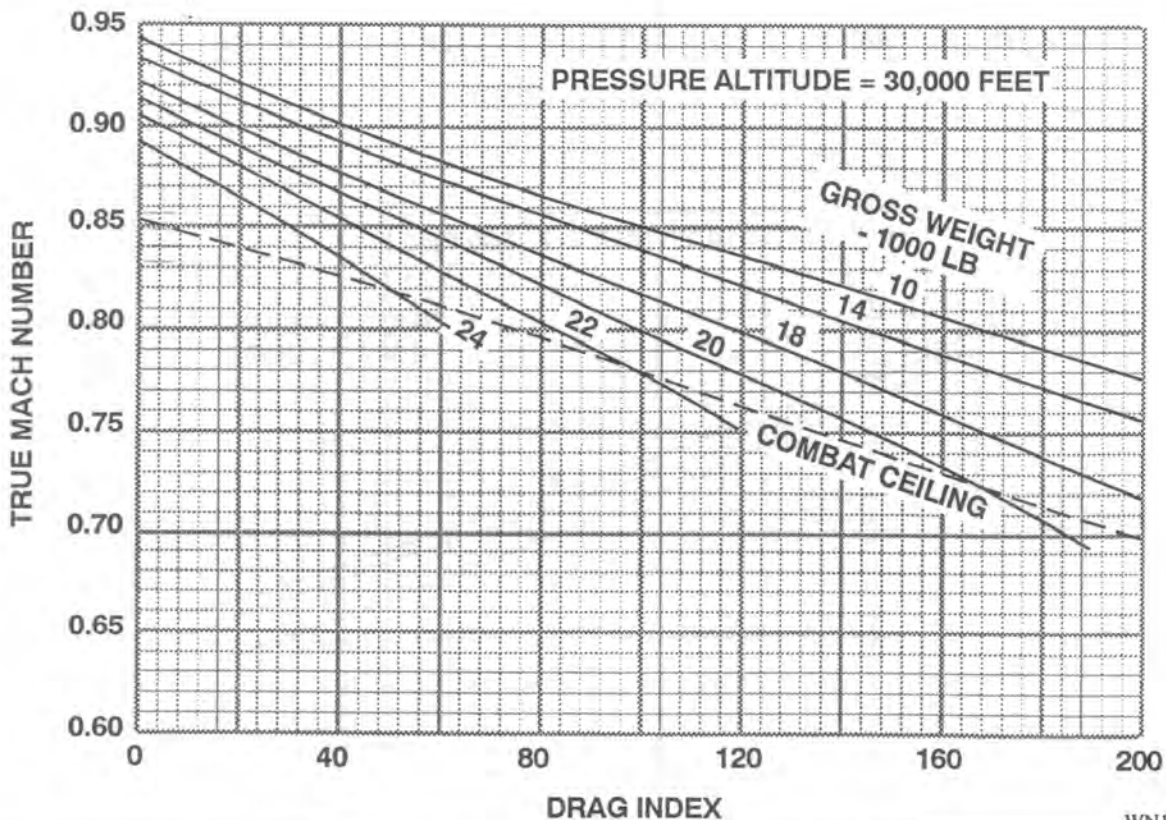
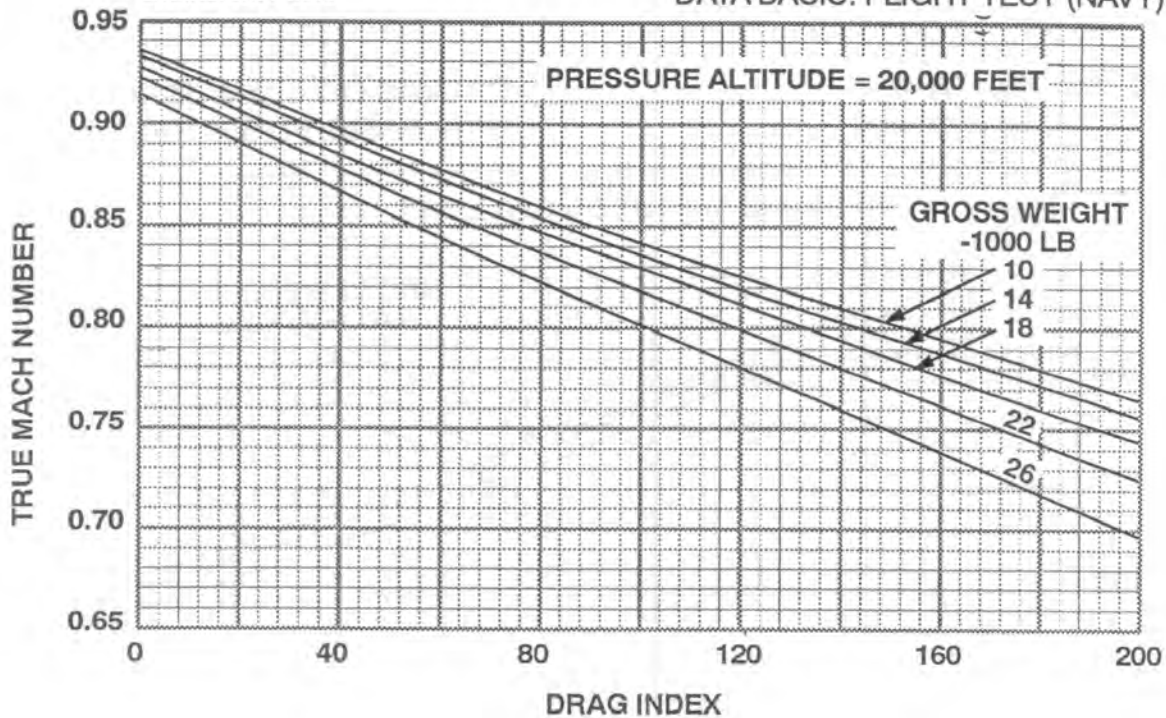
WN1778

Figure 9-98 Maximum Mach Number (Sheet 2 of 3)

MAXIMUM MACH NUMBER **MILITARY THRUST** **ICAO STANDARD ATMOSPHERE**

MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)



WN1781

Figure 9-98 Maximum Mach Number (Sheet 3 of 3)

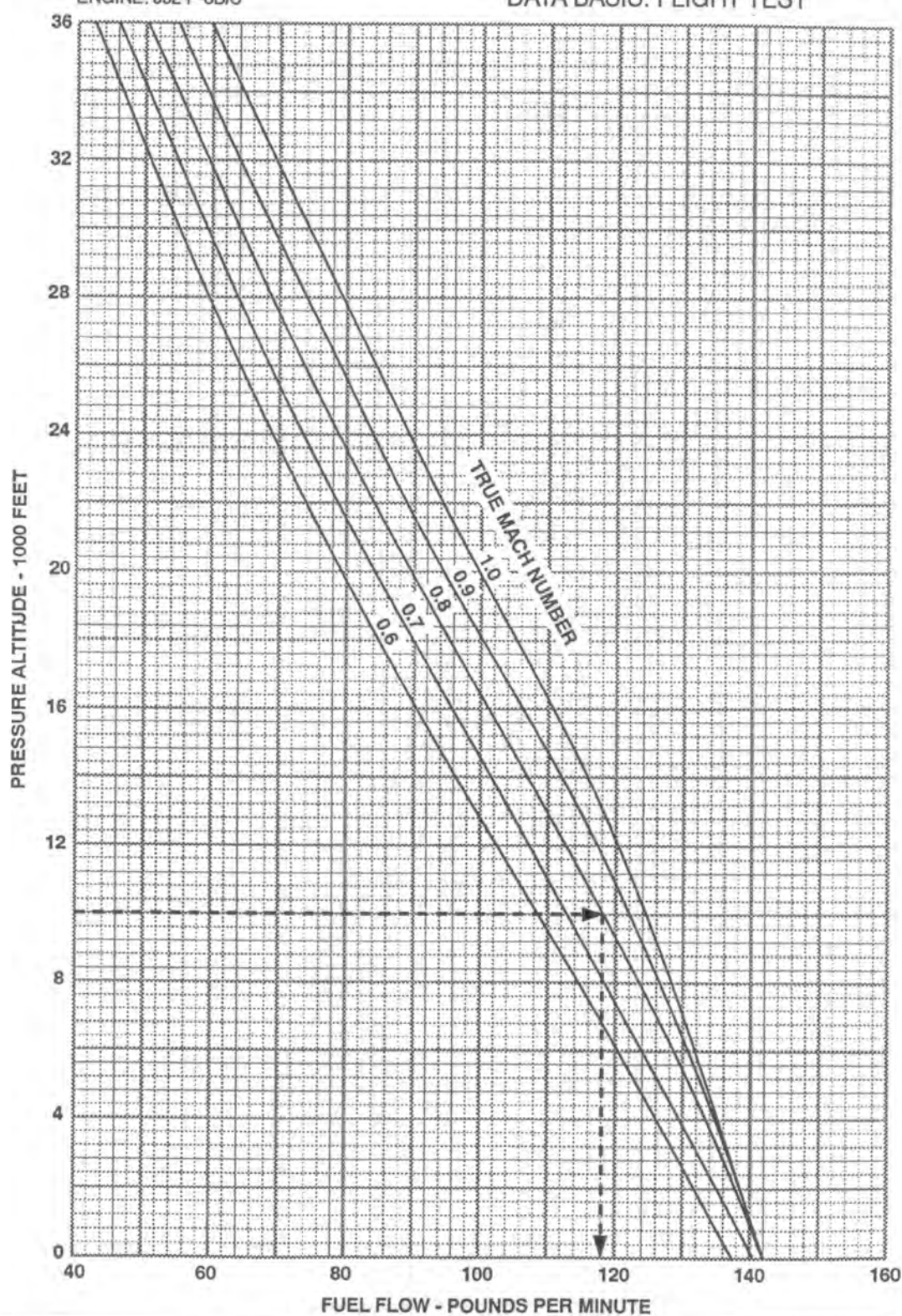
AL 7(0)

MILITARY FUEL FLOW
ICAO STANDARD ATMOSPHERE**MODEL: A-4F**

ENGINE: J52-P-8B/C

DATA AS OF: 15 NOVEMBER 1972

DATA BASIS: FLIGHT TEST



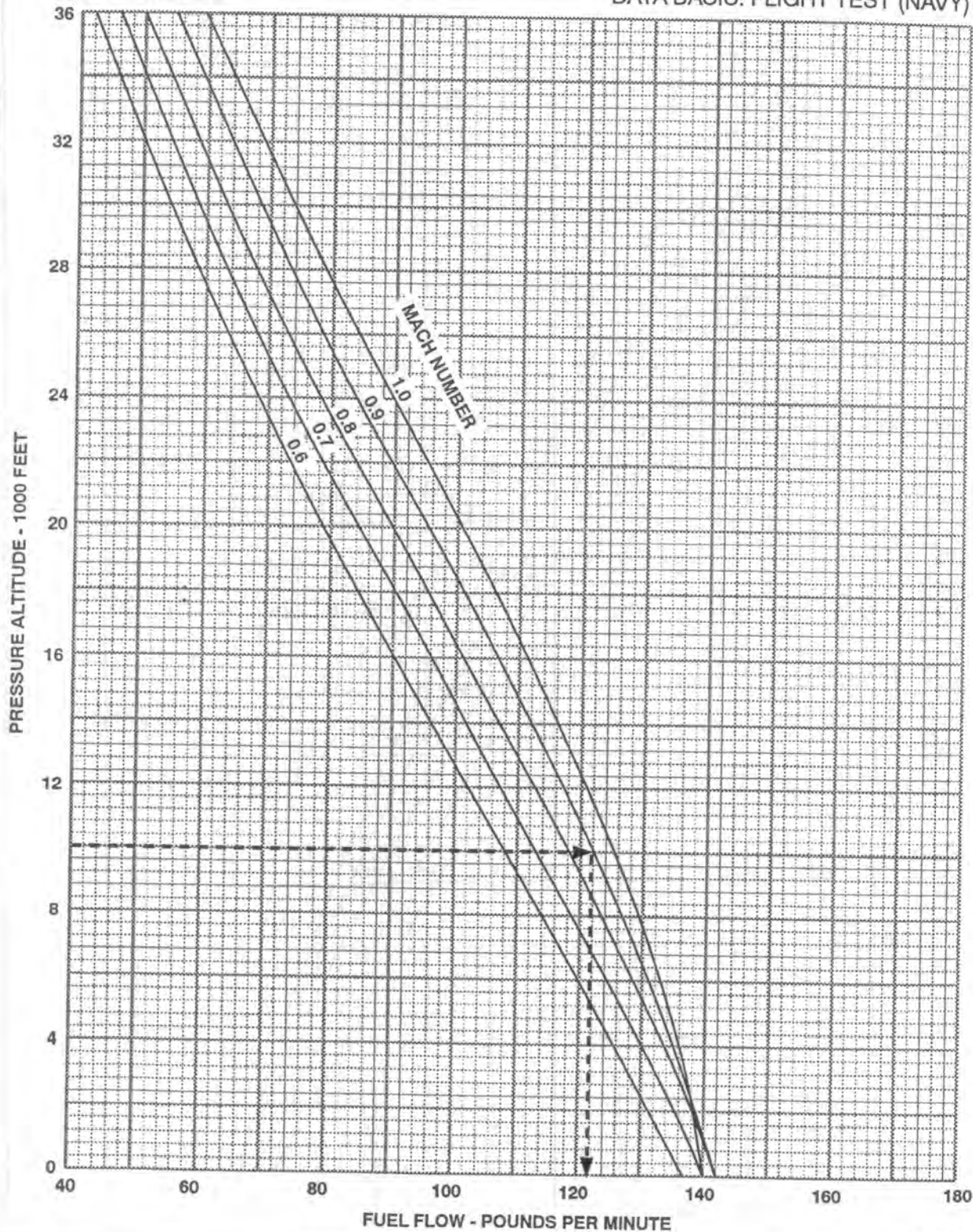
WN1780

Figure 9-99 Military Fuel Flow A-4

MILITARY FUEL FLOW ICAO STANDARD ATMOSPHERE

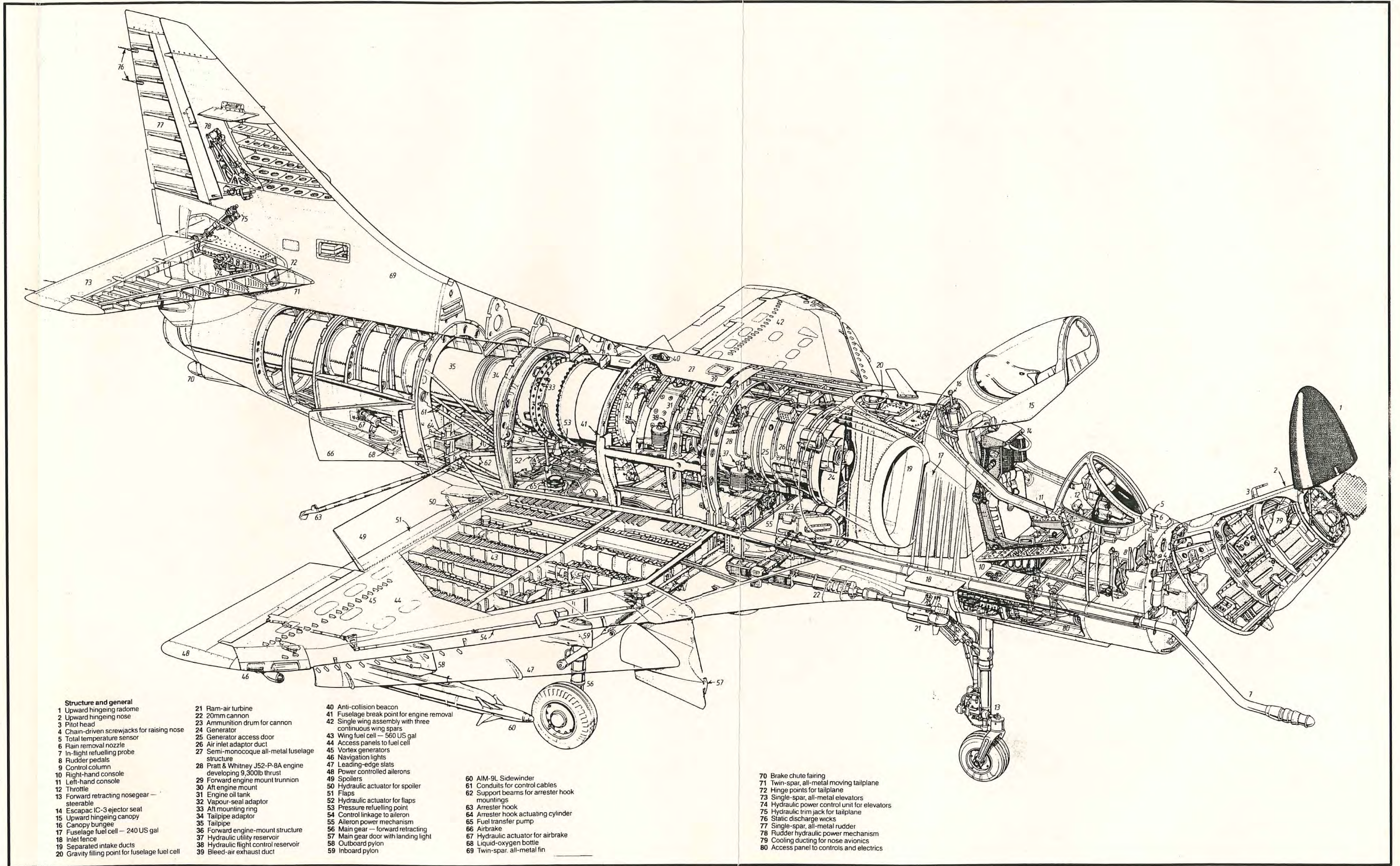
MODEL: TA-4F
ENGINE: J52-P-8B/C

DATA AS OF: 1 MAY 1972
DATA BASIS: FLIGHT TEST (NAVY)

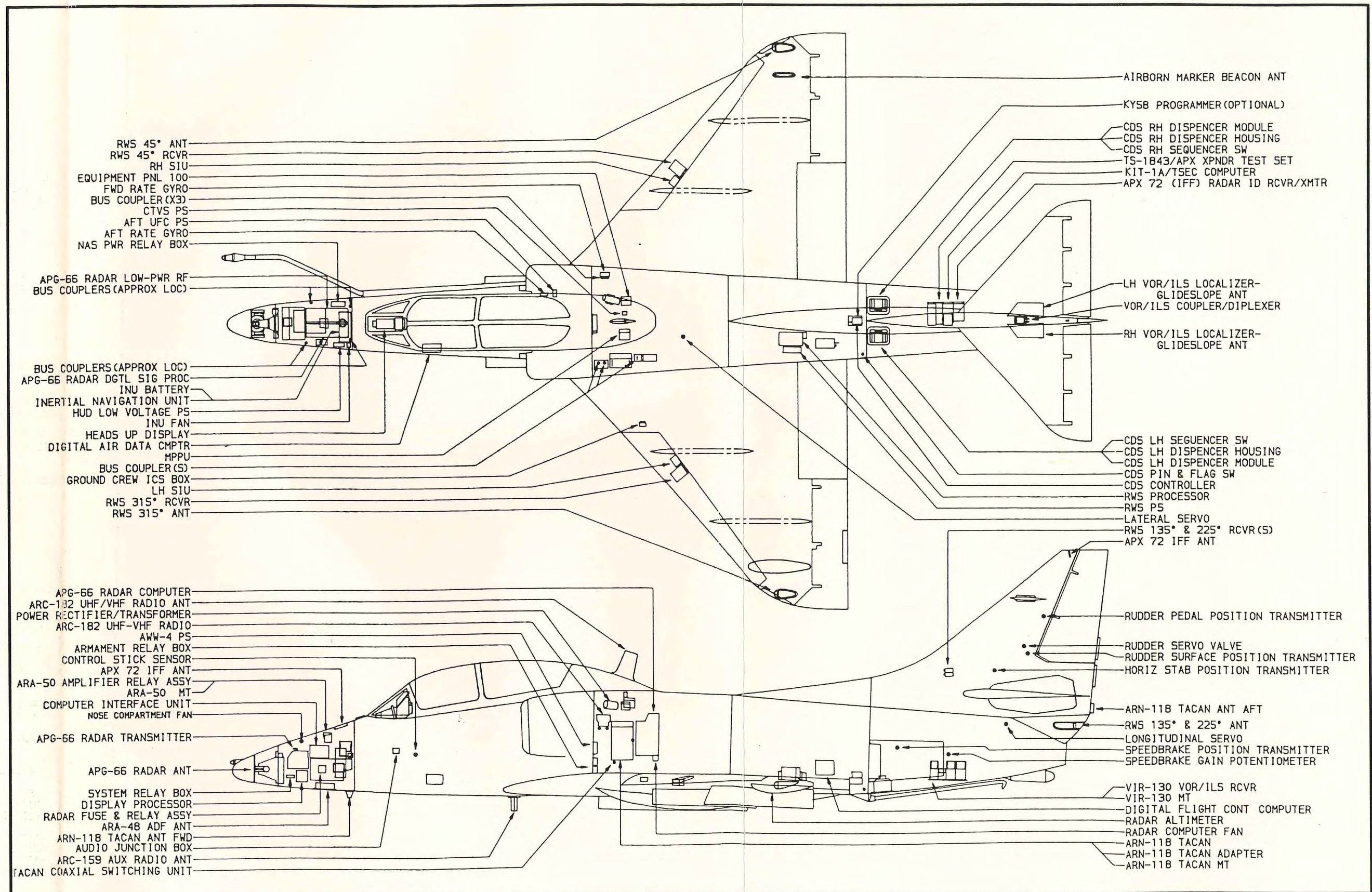


WN1782

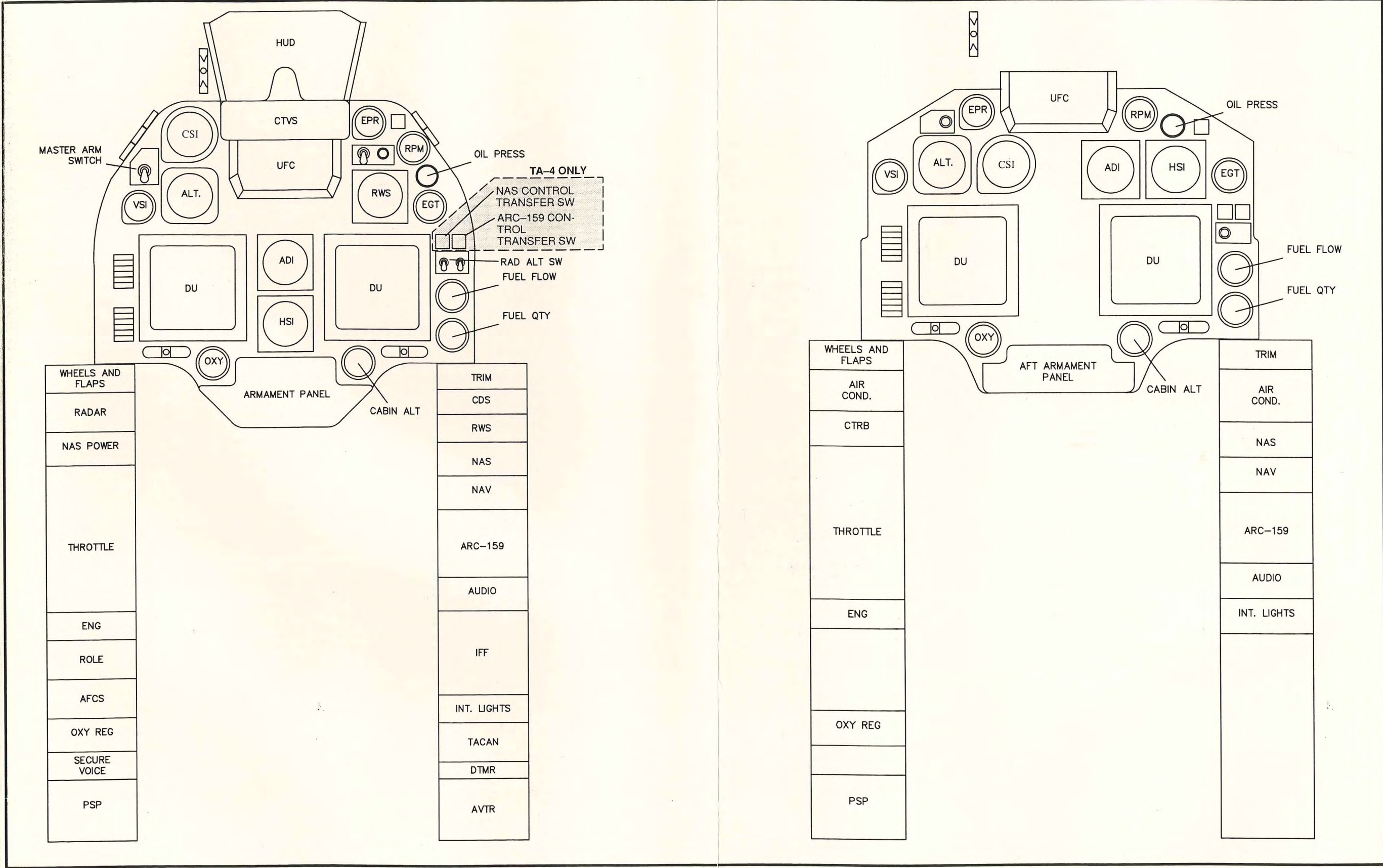
Figure 9-100 Military Fuel Flow TA-4



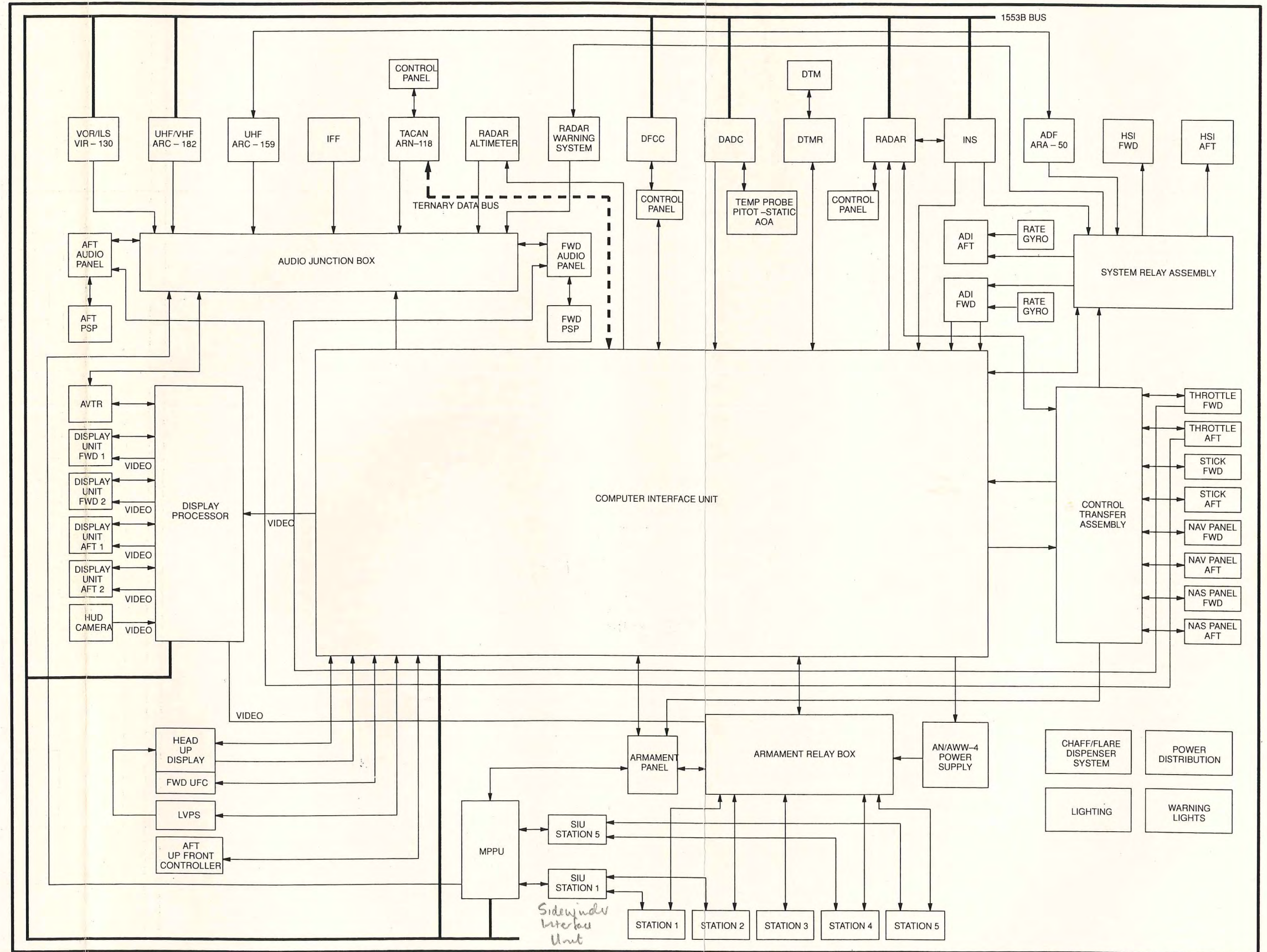
Foldout 1 Aircraft Schematic



Foldout 2 Equipment Locations

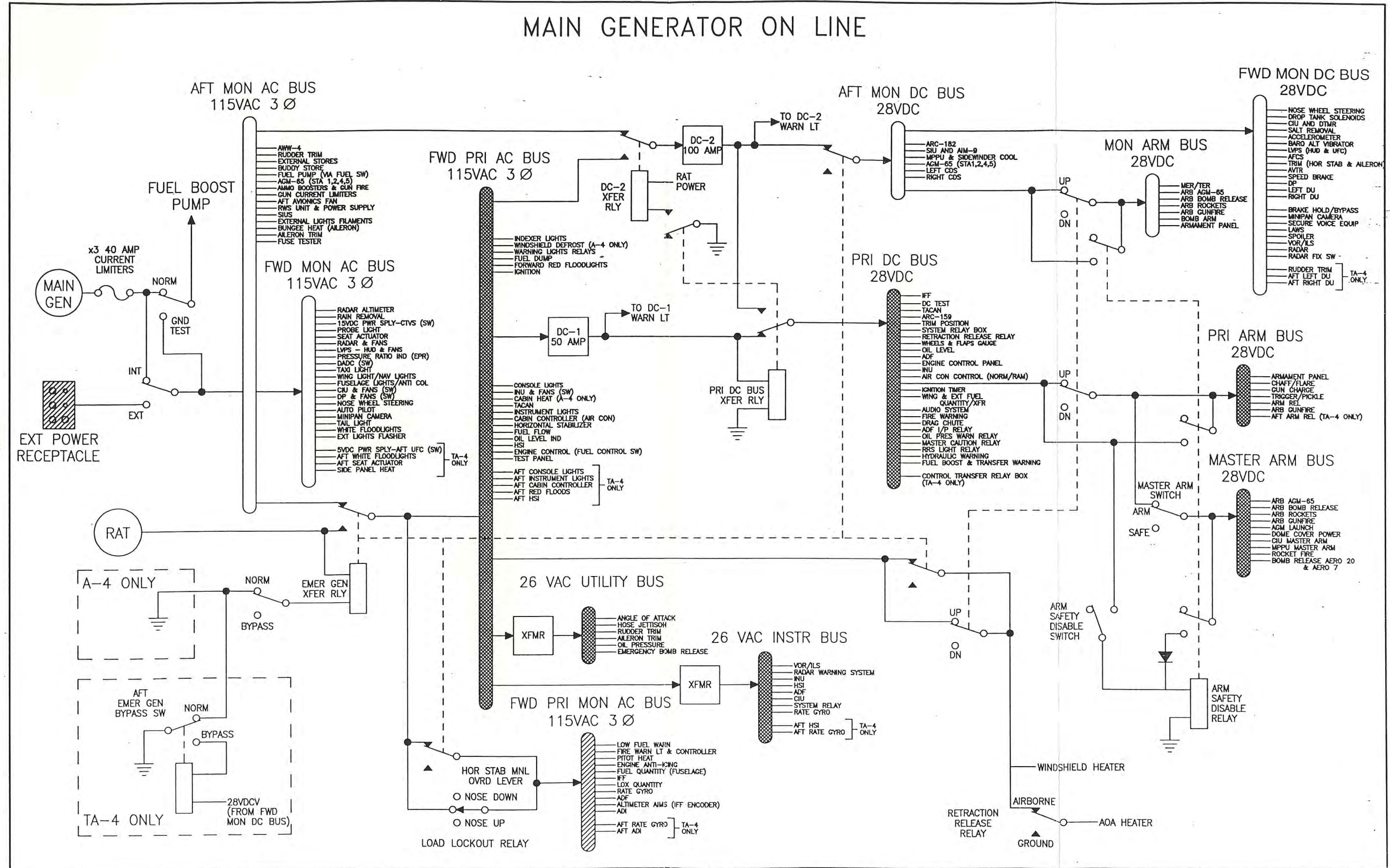


Foldout 3 Cockpit Layouts



Foldout 4 NAS Major Components

AL 5(0)



Foldout 5 Electrical Distribution (Main Generator On Line)

The diagram illustrates the electrical power distribution system for the F-4 Phantom II, showing the flow of power from the Main Generator (MAIN GEN) and Ram Air Turbine (RAT) through various AC and DC buses to numerous aircraft systems.

Power Sources and Distribution:

- MAIN GEN:** Provides power to the FWD MON AC BUS (115VAC 3Ø) and the FWD PRI AC BUS (115VAC 3Ø).
- RAT:** Provides power to the FWD MON AC BUS (115VAC 3Ø) and the FWD PRI AC BUS (115VAC 3Ø).
- EMER GEN:** Provides power to the FWD MON AC BUS (115VAC 3Ø) and the FWD PRI AC BUS (115VAC 3Ø).

AC Buses and Loads:

- FWD MON AC BUS (115VAC 3Ø):** Powers the FUEL BOOST PUMP, RADAR ALTIMETER, RAIN REMOVAL, PROBE LIGHT, SEAT ACTUATOR, RADAR & FANS, LVPS - HUD & FANS, PRESSURE RATIO IND (EPR), DADC (SW), TAXI LIGHT, WING LIGHT/NAV LIGHTS, FUSELAGE LIGHTS/ANTI COL, CIU & FANS (SW), DP & FANS (SW), NOSE WHEEL STEERING, AUTO PILOT, MINIPAN CAMERA, TAIL LIGHT, WHITE FLOODLIGHTS, EXT LIGHTS FLASHER, 5VDC PWR SPLY-AFT UFC (SW), AFT WHITE FLOODLIGHTS, AFT SEAT ACTUATOR, SIDE PANEL HEAT.
- FWD PRI AC BUS (115VAC 3Ø):** Powers the INDEXER LIGHTS, WINDSHIELD DEFROST (A-4 ONLY), WARNING LIGHTS RELAYS, FUEL DUMP, FORWARD RED FLOODLIGHTS, IGNITION, CONSOLE LIGHTS, INU & FANS (SW), CABIN HEAT (A-4 ONLY), TACAN, INSTRUMENT LIGHTS, CABIN CONTROLLER (AIR CON), FIRE WARNING, DRAG CHUTE, FUEL FLOW, OIL LEVEL IND, HSI, ENGINE CONTROL (FUEL CONTROL SW), TEST PANEL, AFT CONSOLE LIGHTS, AFT INSTRUMENT LIGHTS, AFT CABIN CONTROLLER, AFT RED FLOODS, AFT HSI.

DC Buses and Loads:

- FWD PRI DC BUS (28VDC):** Powers the RAT POWER, TO DC-2 WARN LT, TO DC-1 WARN LT, PRI DC BUS XFER RLY, DC-1 50 AMP, DC-2 100 AMP, TO DC-2 WARN LT.
- AFT MON DC BUS (28VDC):** Powers the ARC-182, SU AND AM-9, MPPU & SIDEWINDER COOL, AGM-65 (STA1,2,4,5), LEFT CDS, RIGHT CDS.
- PRI DC BUS (28VDC):** Powers the IFF, DC TEST, TACAN, ARC-159, TRIM POSITION, SYSTEM RELAY BOX, RETRACTION RELEASE RELAY, WHEELS & FLAPS GAUGE, OIL LEVEL, ADF, ENGINE CONTROL PANEL, INU, AIR CON CONTROL (NORM/RAM), IGNITION TIMER, WING & EXT FUEL QUANTITY/XFR, AUDIO SYSTEM, FIRE WARNING, DRAG CHUTE, ADF I/P RELAY, OIL PRES WARN RELAY, MASTER CAUTION RELAY, RRS LIGHT RELAY, HYDRAULIC WARNING, FUEL BOOST & TRANSFER WARNING, CONTROL TRANSFER RELAY BOX (TA-4 ONLY).
- PRI ARM BUS (28VDC):** Powers the ARMAMENT PANEL, CHAFF/FLARE, GUN CHARGE, TRIGGER/PICKLE, ARM REL, ARM GUNFIRE, AFT ARM REL (TA-4 ONLY).
- MASTER ARM BUS (28VDC):** Powers the ARMAMENT PANEL, CHAFF/FLARE, GUN CHARGE, TRIGGER/PICKLE, ARM REL, ARM GUNFIRE, AFT ARM REL (TA-4 ONLY).

Other Systems and Components:

- 26 VAC UTILITY BUS:** Powers the ANGLE OF ATTACK, HOSE JETTISON, RUDDER TRIM, AILERON TRIM, OIL PRESSURE, EMERGENCY BOMB RELEASE.
- 26 VAC INSTR BUS:** Powers the VOR/ILS, RADAR WARNING SYSTEM, INU, HSI, ADF, CIU, SYSTEM RELAY, RATE GYRO, AFT HSI, AFT RATE GYRO (TA-4 ONLY).
- FWD PRI MON AC BUS (115VAC 3Ø):** Powers the LOW FUEL WARN, FIRE WARN LT & CONTROLLER, PITOT HEAT, ENGINE ANTI-ICING, FUEL QUANTITY (FUSELAGE), IFF, LOX QUANTITY, RATE GYRO, ADF, ALTITUDE AIMS (IFF ENCODER), AFT RATE GYRO, AFT ADF (TA-4 ONLY).
- LOAD LOCKOUT RELAY:** Controls the HOR STAB MNL OVRD LEVER, NOSE DOWN, NOSE UP.
- ARM SAFETY DISABLE RELAY:** Controls the ARM SAFETY DISABLE SWITCH, ARM SAFETY DISABLE RELAY.
- WINDSHIELD HEATER:** Powers the WINDSHIELD HEATER.
- AOA HEATER:** Powers the AOA HEATER.
- RETRACTION RELEASE RELAY:** Controls the RETRACTION RELEASE RELAY.

Page FO-6

BIT HISTORY PAGE 1 OF 2

BIT HISTORY PAGE 1 OF 2																WORD	
MAIN CPU BIT	MAIN PROCESSOR I/O	MAIN OFF CHECKSUM	MAIN SUR CHECKSUM	MAIN RAM I/O	MAIN BUS TIMEOUT	MAIN TIMER A/B	MAIN DEAD MAN TIMER	MAIN INSTRUCTION I/O	MAIN FL PT OVERFLOW	MAIN FX PT OVERFLOW	MAIN GBL MEM I/O	RESERVED RTC	INTERPROC COMM	INTERPROC INTERRUPT	MAIN BATTERY	CIU	0
I/O CPU BIT	PROCESSOR I/O	I/O OFF CHECKSUM	I/O SUR CHECKSUM	I/O RAM	I/O BUS TIMEOUT	I/O TIMER A/B	I/O DEAD MAN TIMER	I/O INSTRUCTION	I/O FL PT OVERFLOW	I/O FX PT OVERFLOW	I/O GBL MEM	READ/WRITE	RTC COUNT	GLOBAL BATTERY	RAM BATTERY		1
AIU BIT FAIL	AIU RESPONSE	AIU OVERRUN	AIU ILLEGAL CMD CHAIN	TACAN INT INTERRUPT	TACAN INTER WRAP	RS-422 INT INTERRUPT	RS-422 INTER WRAP	NEG 5V REF	DC OUTPUT FAIL	AC OUTPUT FAIL	AC REF FAIL	COMMAND CHECK	BOMB ENBL DISCRETE	GUN FIRE DISCRETE	RCKT ENBL DISCRETE		2
CAL FAIL MUX 1	CAL FAIL MUX 2	CAL FAIL MUX 3	CAL FAIL MUX 4	CAL FAIL MUX 5		RAD ALT AIB	SLEW EXIT AIB	28V DC AIB	STAD RNG AIB	AGM-65 AZ AIB	AGM-65 EL AIB	AZ SL RATE FWD AIB	EL SL RATE FWD AIB	AZ SL RATE AFT AIB	EL SL RATE AFT AIB		3
INPUT DISCRETE 0	INPUT DISCRETE 1	INPUT DISCRETE 2	INPUT DISCRETE 3	INPUT DISCRETE 4	INPUT DISCRETE 5	DISCRETE WORD 0	DISCRETE WORD 1	DISCRETE WORD 2	DISCRETE WORD 3	DISCRETE WORD 4	DISCRETE WORD 5						4
CUR DWG	CUR DWG	CUR DWG	CUR DEFL TEST 1	CUR DEFL TEST 2	CURSIVE WINDOW	CURSIVE TIMING	RASTER DRAWING	RASTER WINDOW	O-RANGE TEST	PDU DEFLECTION							
PDU BIT	PDU 2	PDU 1	PDU 0	PDU 5V DC	PSU FAIL	VIDEO TEST 1	VIDEO TEST 2	SCAN FAIL			CTVS FAIL	SGCS FAIL	SYMBOL STORES	SGCS MUX	SGCS COUNTERS	HUD	0
INU FAIL				INU ATTITUDE				INU ANAL ATT FAIL				INU NAV FAIL	HUD SGCS I-BIT FAIL	LVPS FAIL	HUD FAIL		1
DADC FAIL				DADC I-BIT										INU COMM FAIL	INU SGL BUS FAIL	INU	
PRESSURE ALTITUDE	BARO-CORR ALTITUDE	TRUE AIRSPEED	MACH	INDICATED AIRSPEED	PRESSURE RATIO	TRUE AOA	STATIC TEMP	ALTITUDE RATE	MACH RATE	TOTAL PRESSURE	BAROSET PRESSURE	INDICATED AOA	TOTAL TEMP	DADC COMM	DADC SGL BUS FAIL	ADC	0
DFCC FAIL	AUTOPILOT FUNCTION	STAB AUG	LONG SERVO	LATERAL SERVO	RUD SERVO	SPEEDBRAKE POS XMT	PEDAL POS XMT	STICK XDUCE	HOR STB ACT POS XMT	HOR STB TRM TRANS RLY	RET REL RELAY	AFCS PANEL	DFCC WRAP	DFCC COMM	DFCC SGL BUS FAIL	A/P	1
DP CPU BIT	DP PROCESSOR	DP OFF CHECKSUM	DP SUR CHECKSUM	DP RAM	DP BUS TIMEOUT	DP TIMER A/B	DP DEAD MAN TIMER	DP INSTRUCTION	DP FL PT OVERFLOW	DP FX PT OVERFLOW	RESERVED	RAM BATTERY	DP WRAP	DP COMM	DP SGL BUS FAIL	DP	0
AIU BIT FAIL	AIU RESPONSE	AIU OVERRUN	AIU ILLEGAL CMD CHAIN	CHAR GEN	CHAR GEN TIMEOUT	CHAR GEN I-BIT	RS422 INTER INTERRUPT	RS-422 INTER WRAP		INPUT DISCRETE 0	INPUT DISCRETE 1			DISCRETE WORD 0	DISCRETE WORD 1		1
FWD LEFT DU		FWD RIGHT DU		AFT LEFT DU		AFT RIGHT DU							AVTR FAIL			DIS	

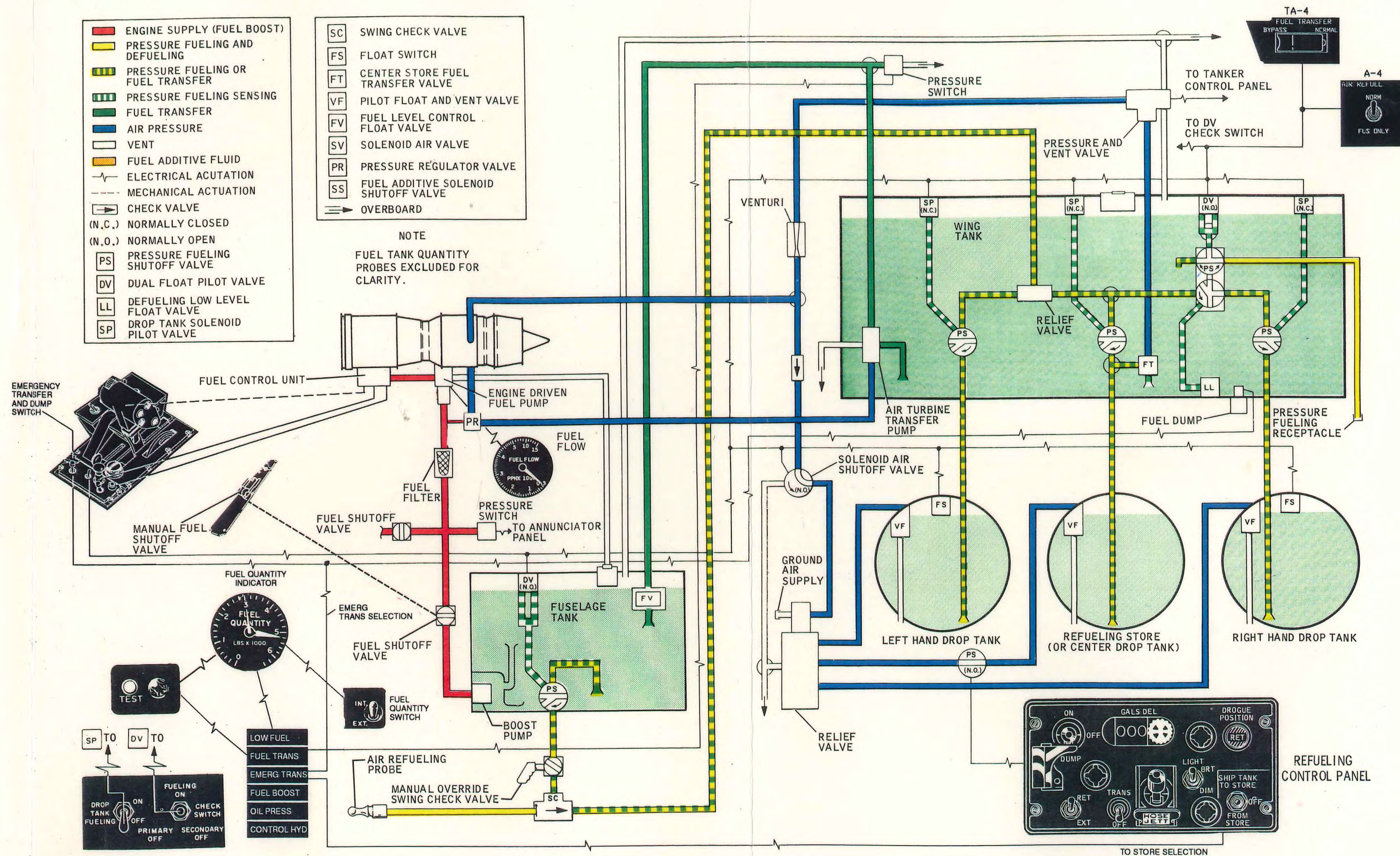
BIT HISTORY PAGE 2 OF 2

BIT HISTORY PAGE 2 OF 2																WORD	
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TACAN BIT				TACAN TUNING				TACAN I-BIT						TACAN COMM	RADAR SGL BUS FAIL	TCN	
RADAR MAJOR	RADAR MINOR	SELFTEST FAULT	RADAR I-BIT EXC	RADAR ANTENNA	RADAR TRANS	RADAR LPRF	RADAR DSP	RADAR COMPUTER	RADAR PANEL					RADAR COMM		RDR	0
SEA 1 BIT 0	SEA 2	SEA 2 BIT 0	TGT VIDEO BIT 0	A/D SAT	RCVR VER	STALO SPEC PURITY	BEACON DETECT										1
TK 128 RNG GATES	TK 8 PRF	ACM SEARCH	UPLOOK SEARCH	CFAR 3X9	CFAR 5X7	CFAR DET DOWNLOOK	CFAR DET UPLOOK	CFAR DET ACM	REAL BEAM MAP	REAL BEAM MAP (BIT 0)	DBS RCP WORD 3	AGR BIT 0	BEACON RCP	DBS BIT 0	SEA 1		2
NOISE FIGURE	COMP WAT BIT 0	RCP SEARCH	ANT DIGIBUS WAT	LPRF	XMTR DIGIBUS WAT	DSP BUS EXT WAT	AA PA	AA PE	RCP SEQ 2	RCP SEQ 1	RX PROT CAL	RCP WORD 2	WORD 1	SYNCHRO-NIZER	MICRO-PROCESSOR DUMPED O/E RNG GATES		3
XMTR OK	PEAK DETECT	ANT ARC	PHA4NL	DIGIBUS WAT DRIVE CUR OK	AZELON	LSWRNG	IPWRLO	A/D DC OFFSET CAL	NOISE AGC CAL	VCXO CAL	LO 1 FAIL	XMTR CAL	LPRF OSC FREQ CAL	HV ON	XMTR TIMEOUT		4
RP FAIL		BEACON LO FAIL	VCO HTR FAIL	AC MUX BUS BIT 0	CPU INT TEST	DSP BUS INT WAT	RTC TEST	PLL FAIL	LO 3 FAIL	LO 2 FAIL	LO 1 FAIL	LOSS OF XMT OK	XMTR ARC	LPRF CLK DETECT	RAM PAT TEST		5
INSTRUCTION	CHECKSUM #1A	CHECKSUM #1B	CHECKSUM #2				SCS LOAD ERROR	DISCRETE WAT		RADAR READY	A/C BUS B BIT COMP	A/C BUS A BIT COMP	A/D CIRCUITS	SCS COMM	SCS SGL BUS FAIL	SCS	6
SCS MPPU	SCS LSIU	SCS RSIU	SCS SSU					LL MISSILE ERROR	LR MISSILE ERROR	RL MISSILE ERROR	RR MISSILE ERROR	SCS I-BIT	SCS WRAP	SCS COMM			
28 VDC				15V DC PWR SUP				ADI FAIL				HSI FAIL				A/C	0
RADAR ALTIMETER															RESERVED		1

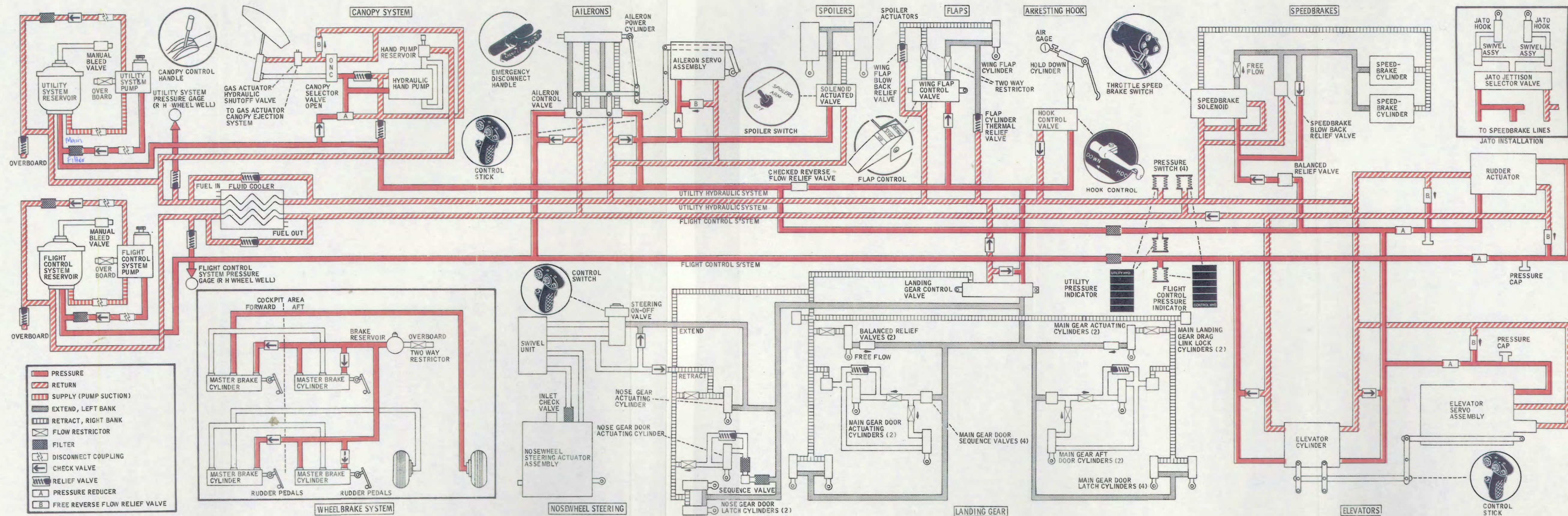
Foldout 7 BIT History Page Bit Assignments

FAILURE	RESULTS																	
					COMM / NAV					WEAPONS	AFCS	RADAR	RWS	DTS	CTVS	AVTR	RAD ALT	DADC
	HUD	DU	HSI	ADI	VOR/ILS	TACAN	ARC-182	NAS	OFFSET NAVAID									
CIU	Only Standby sight available	All video good except for overlays. Text data base good if loaded prior to CIU fail	No course deviation, to/from, or course command during NAS navigation	No NAS steering	Backup tuning through DU	Fully operational through TACAN control panel	Backup tuning provided through DU	No course deviation, to/from, or course command bearing and distance still active	Inoperative	Manual through Armament Panel No Maverick	NAS-coupled steering not available	Inop	No heading	Inactive		No auto mode No event marking	No readout No LAW tone	No air data displays
DP		Default video LDU - Radar RDU - Maverick No video in rear cockpit			No marker beacon sensitivity control (defaults to HI)	If TACAN panel set to 00, mode defaults to T/R	No mode controls (defaults to man preset, TR + G, squelch ON, and UHF-AM)	No AUTO/MAN sequencing control (defaults to MAN)		Can't change A/G program data	NAS-coupled steering not available					No video recording Audio recording still available		
INU	Degraded nav and weapons displays		TACAN or VOR bearing against heading card which is fixed at 360° Relative ADF only	No NAS steering	VOR bearing active against heading card which is fixed at 360°	TACAN bearing against heading card which is fixed at 360° DME good		Inoperative	Inoperative	Manual weapon delivery only	Inop	No pitch, roll, or rate data	No heading					
HUD	Only Standby sight available				No HUD displays	No HUD displays		No HUD displays	No HUD displays	No NAS generated weapon displays on HUD				No loading or unloading				
UFC	No data entry				Backup tuning through DU	Backup tuning through DU or TACAN panel	Backup tuning through DU	No data entry	No data entry	Backup entry through DU		No radar updates or marks		inactive				
CTVS		No HUD video in rear cockpit													Inop	No HUD recording		
VOR/ILS	No VOR/ILS displays		No VOR/ILS displays	No VOR/ILS displays	Inoperative													
TACAN	No TACAN displays		No TACAN displays			Inoperative		No navaid updates	Inoperative									
RAD ALT	No rad alt display							No rad alt data		No rad alt data							Inop	
RADAR		No radar video						No radar nav functions		No radar weapons functions		Inop				No radar video recording		
DADC	No air data displays									No air data	No air data							Inop

Foldout 8 Multiple Effect Failure Matrix



Foldout 9 Fuel System



Foldout 10 Hydraulic System

